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Vol. I

TRANSCRIPT OF RECORD

Supreme Court of the United States.

OCTOBER TERM, [REDACTED] 1938

No. [REDACTED] 1

GENERAL TALKING PICTURES CORPORATION,
PETITIONER,

v.s.

WESTERN ELECTRIC COMPANY, INC., ELECTRI-
CAL RESEARCH PRODUCTS, ET AL.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT
OF APPEALS FOR THE SECOND CIRCUIT

[REDACTED]

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Patentee Patent No. Claims relied on.

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879,532	DeForest	Feb. 18, 1908	1428
884,110	Stone, <i>et al.</i>	Apr. 7, 1908	1432
995,126	DeForest	June 13, 1911	1435
1,012,456	Seibt	Dec. 19, 1911	1438
1,038,910	Von Lieben, <i>et al.</i>	Sept. 17, 1912	1441
1,114,845	Arnold	Oct. 27, 1914	1446
1,127,371	Pierce	Feb. 2, 1915	1448
1,129,942	Arnold	Mar. 2, 1915	1453
1,129,943	Arnold	Mar. 2, 1915	1459
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1,227,113	Campbell	May 22, 1917	1472
1,234,489	Reisz	July 24, 1917	1483
Re 14,380	Colpitts	Oct. 23, 1917	1486
1,257,381	Nichols	Feb. 26, 1918	1491
1,330,471	Kendall	Feb. 10, 1920	1497

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1,340,101	Alexanderson	May 11, 1920	1502	
1,350,752	Van der Bijl	Aug. 24, 1920	1507	
1,375,447	DeForest	Apr. 19, 1921	1514	
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1,384,108	Weagant	July 12, 1921	1528	
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1,398,665	Arnold	Nov. 29, 1921	1541	
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1,448,550	Arnold	Mar. 13, 1923	640	
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IN THE
United States District Court
SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,
against.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

In Equity,
on Letters Patent
1,329,283,
1,349,252,
1,398,665,
1,432,863,
1,442,439,
1,448,550,
1,520,994.

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Bill of Complaint (Equity No. 50-175).

TO THE HONORABLE THE JUDGES OF THE DISTRICT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK:

Plaintiffs, by this Bill of Complaint, allege: 3

1. That plaintiff, Western Electric Company, Incorporated, is a corporation duly organized and existing under and by virtue of the laws of the State of New York and is a citizen of said State; that plaintiff, Electrical Research Products, Inc., is a corporation duly organized and existing under and by virtue of the laws of the State of Delaware and is a citizen of said State; that plaintiff, American Telephone and Telegraph Company, is a corporation duly organized and existing under and by virtue of the laws of the State of New York and is a citizen of said State;

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that plaintiff, Western Electric Company, Incorporated, is a subsidiary of said plaintiff, American Telephone and Telegraph Company, more than 98% of its corporate stock being owned by said Company; and that plaintiff, Electrical Research Products, Inc., is a subsidiary of plaintiff, Western Electric Company, Incorporated, its entire corporate stock being owned by said Company.

5

That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation existing under and by virtue of the laws of the State of New York and is a citizen and resident of said State.

That this is a suit in equity arising under the patent laws of the United States for infringement of the following Letters Patent:

	<i>Inventor</i>	<i>Patent No.</i>	<i>Date of Issue</i>	<i>Filing Date of Application</i>
6	H. D. Arnold	1,329,283	Jan. 27, 1920	July 30, 1918
	H. D. Arnold	1,349,252	Aug. 10, 1920	Mar. 20, 1916
	H. D. Arnold	1,398,665	Nov. 29, 1921	Jan. 8, 1920
	K. S. Johnson	1,432,863	Oct. 24, 1922	July 1, 1918
	R. C. Mathes	1,442,439	Jan. 16, 1923	Nov. 4, 1916
	H. D. Arnold	1,448,550	Mar. 13, 1923	Feb. 3, 1919
	H. D. Arnold	1,520,994	Dec. 30, 1924	Mar. 28, 1919

Plaintiffs are informed and believe and therefore aver, with respect to each of the patents in the foregoing list; That the inventor therein named was, prior to the filing date of the application therefor as above given, the first, original and sole inventor of the improvements

Bill of Complaint (Equity No. 50-175).

and inventions covered thereby, which improvements and inventions were not known or used by others in this country before his invention or discovery thereof and were not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof or more than two years prior to said filing date, and were not in public use or on sale in this country for more than two years prior to said filing date, and had not been abandoned, and had not been patented nor caused to be patented by himself or his legal representatives or assigns in any foreign country upon an application filed more than twelve months prior to said filing date; that on said filing date he duly filed in the United States Patent Office an application for Letters Patent for said improvements and inventions; and that prior to the said date of issue all of the requirements of the statutes of the United States then in force had been duly complied with.

5. That the aforesaid inventors, Arnold, Johnson and Mathes, having severally assigned to the Western Electric Company, Incorporated, their entire right, title and interest in and to the respective applications filed by them as aforesaid and the inventions and improvements therein disclosed, said Patents No. 1,329,283, No. 1,349,252, No. 1,398,665, No. 1,432,863, No. 1,442,439, No. 1,448,550 and No. 1,520,994 were duly issued to plaintiff, Western Electric Company, Incorporated, its successors and assigns; that by instruments in writing duly executed and delivered on or about October 26, 1920, December 14, 1922, February 5, 1924 and January 20, 1926, respec-

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Bill of Complaint (Equity No. 50-175).

tively, and recorded in the United States Patent Office, said Western Electric Company, Incorporated, duly assigned and transferred to plaintiff, American Telephone and Telegraph Company, the entire right, title and interest in and to the said several patents.

6. That plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are, and at the time of the infringement herein complained of were, engaged in making, selling, leasing, installing and using apparatus for recording sound and apparatus for reproducing sound from records thereof by virtue of licenses from plaintiff, American Telephone and Telegraph Company, under the patents aforesaid for certain purposes, including the field of use of the infringement complained of; and that by an instrument in writing executed and delivered on or about the 7th day of May, 1929, said American Telephone and Telegraph Company confirmed the aforesaid licenses to plaintiff, Western Electric Company, Incorporated, and Electrical Research Products, Inc., and assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., all its rights under or arising from said patents to exclude others from the manufacture, sale, lease, installation and/or use of apparatus, devices, systems or methods for certain purposes, including the field of the infringement herein complained of; and also assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., all claims which had arisen, or which might thereafter arise, out of the in-

fringement of the aforesaid patents within the field of said purposes and the rights for their own benefit to bring suit against any infringer in said field.

7. And plaintiffs pray that the aforesaid Letters Patent, instruments, assignments and agreements in writing may be deemed and taken as a part of the Bill of Complaint and plaintiffs ask leave to refer to the originals of the same or duly authenticated copies thereof, all of which they stand ready in court to produce. 14

8. That, by virtue of the assignments aforesaid, plaintiff, American Telephone and Telegraph Company, is, and has, at all times since the date of said assignments to said Company, including the time of the infringement herein complained of, been the owner of said Letters Patent No: 1,329,283, No. 1,349,252, No. 1,398,665, No. 1,432,863, No. 1,442,439, No. 1,448,550 and No. 1,520,994, and plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are entitled to sue jointly with plaintiff, American Telephone and Telegraph Company, for injunctive relief for the infringement of said patents herein complained of and to recover profits and/or damages arising out of said infringement. 15

9. That plaintiffs have expended large sums of money in making the inventions of said Letters Patent profitable to themselves and their licensees and useful to the public; that they and their licensees have made and sold or caused to be made and sold large numbers of systems, ap-

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paratus and electrical amplifiers embodying said inventions and improvements, for the purpose, among others, of the electrical reproduction of sound from records thereof in accompaniment with motion pictures, said systems, apparatus and electrical amplifiers having had affixed thereto the word "Patented" together with the days and years said respective Letters Patent applicable thereto were granted and/or the numbers thereof as provided by Section 4900 of the

17 Revised Statutes of the United States; and that, the inventions and improvements of said Letters Patent are of great value, importance, benefit and advantage to the public.

10. That the inventions of said Letters Patent are capable of conjoint use in one and the same unitary structure, device, amplifier or equipment and have been and now are being so used by the defendant in the infringement complained of herein.

18 11. That, as plaintiffs are informed and believe and therefore aver, defendant, without a license under any of said several Letters Patent, and in violation and infringement of each of said Letters Patent, has, within the last six years and prior to the filing of this Bill of Complaint and subsequent to the issue of each of said patents and to the assignments thereof to the plaintiff, American Telephone and Telegraph Company, unlawfully and wrongfully made or caused to be made, sold and used within the United States devices, apparatus, systems, structures, amplifiers and arrangements including arrangements for commercial use in the electrical

reproduction of sound from records thereof in accompaniment with motion pictures, each and all containing the inventions and improvements of each of said Letters Patent or substantial, material and vital parts thereof and each and all infringing upon and/or contributing to the infringement of each of said Letters Patent and upon the aforesaid rights of plaintiffs under each of said Letters Patent and the claims thereof.

12. That, as plaintiffs are informed and believe and therefore aver, defendant has derived and received and will derive and receive from the infringement complained of large gains, profits and advantages, but to what amount plaintiffs are ignorant and cannot set forth; that by reason of said infringement plaintiffs have been and will be deprived of and prevented from receiving, if such infringement is not forthwith restrained by this court, gains, profits and advantages to which plaintiffs are lawfully entitled and which they would have derived and received and would now be deriving and receiving but for the aforesaid infringement; that by reason of the aforesaid infringement plaintiffs have been irreparably injured and have sustained losses and damages therefrom; that unless the infringement is immediately restrained further immediate irreparable injury, loss and damage will be caused to the rights of plaintiffs.

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13. That, as plaintiffs are informed and believe and therefore aver, defendant prior to the commencement of this suit had full knowledge of said several Letters Patent and the aforesaid infringement thereof but notwithstanding such

knowledge is now continuing and threatening to continue said infringement.

WHEREFORE, plaintiffs pray:

23

1. That a perpetual injunction may be issued enjoining and restraining said defendant and its officers, associates, agents, attorneys, servants, workmen, employees, and each of them, and all those in privity therewith, from in any way infringing directly or indirectly or contributing to the infringement of the said Letters Patent or any of the claims thereof.

2. That a preliminary injunction of the same tenor and effect as the perpetual injunction hereinbefore prayed for may issue against said defendant pending the determination of this suit and until further order of this court.

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3. That defendant be ordered and decreed to deliver to plaintiffs each and all of said infringing devices, apparatus, amplifiers or arrangements which it has in its possession or under its control or that the same may be destroyed or that they may be delivered into court or be impounded by the court for such final disposition as to the court may seem just or proper.

4. That defendant be required to account for and pay over to plaintiffs such gains and profits as have accrued or arisen or been earned or received by the said defendant and all such gains and profits as would have accrued to plaintiffs but for the unlawful doings of said defendant, and all damages plaintiffs have sustained thereby, and that the Court will assess the same or

Bill of Complaint (Equity No. 50-175).

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cause them to be assessed under its direction and will increase the same in its discretion as provided by law.

5. That defendant may be decreed to pay the costs, charges and disbursements in this suit and that plaintiffs may have such other and further relief as the circumstances and the equity of the case may require.

Answer under oath is hereby expressly waived.

WESTERN ELECTRIC COMPANY, INCOR-
PORATED,

26

By (S) GEO. C. PRATT,
Vice President.

ELECTRICAL RESEARCH PRODUCTS, INC.,

By (S) J. J. LYNG,
Vice President.

AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,

By (S) CHARLES M. BRACELEN,
Vice President.

CHARLES NEAVE,

27

Solicitor and of Counsel for Plaintiffs.

(S) FRANKLIN T. WOODWARD,
(S) WILLIAM R. BALLARD,
of Counsel for Plaintiffs.

State of New York, }
County of New York, }ss.:

CHARLES M. BRACELEN, being duly sworn deposes and says that he is Vice President of the American Telephone and Telegraph Company, one of the plaintiffs named in the foregoing Bill of Complaint, and that he has read the same and

28 *Amendment to Bill of Complaint (Equity No. 50-175).*

knows the contents thereof, and that the same is true to his own knowledge except as to the matters therein stated to be alleged on information and belief and as to these matters he believes them to be true; that the reason why this verification is not made by said plaintiff personally is that this plaintiff is a corporation.

(S) CHARLES M. BRACELIN.

29 Sworn to before me this
12th day of September, 1929.

(S) H. W. HOLLSBERG,
Notary Public.

Amendment to Bill of Complaint (Equity No. 50-175).

UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.

30

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

Equity No.
50-175.

GENERAL TALKING PICTURES
CORPORATION,
Defendant.

Now come the plaintiffs and, in accordance with the provisions of Equity Rule 28, amend

*Amendment to Bill of Complaint (Equity
No. 50-175).*

31

the bill of complaint herein in the following respects:

1. Paragraph 2 of the bill of complaint is hereby amended to read as follows:

"That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation of the State of Delaware, and has a regular and established place of business within the Southern District of New York in which District and elsewhere within the United States it has committed the acts of infringement hereinafter complained of."

32

2. Paragraph 11 of the bill of complaint is hereby amended by inserting in line 9 of the said paragraph after the word "within" the following:

the Southern District of New York and elsewhere in

33

WESTERN ELECTRIC COMPANY, INCORPORATED,
ELECTRICAL RESEARCH PRODUCTS, INC.,
AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,

By CHARLES NEAVE,
Solicitor for Plaintiffs.

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Answer (Equity No. 50-175).

UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

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Plaintiffs,

vs.

GENERAL TALKING PICTURES CORPORATION,

Defendant.

Equity No.
50-175.

For answer to the bill of complaint herein or to as much thereof as defendant is advised is material or required to be answered, defendant says:

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1. Defendant denies each and every allegation contained in paragraph 2 of the bill of complaint and to the contrary asserts that it is a corporation of the State of Delaware; has committed no acts of infringement within the Southern District of New York and denies that this Court has jurisdiction over it.

2. Defendant denies each and every allegation contained in paragraphs 4, 5 and 6 of the bill of complaint except that it admits having seen what purported to be printed copies of the patents specified in paragraph 3 of the bill of complaint.

3. Defendant has no information sufficient upon which to form a belief as to the matters alleged in paragraph 8 of the bill of complaint and therefore denies the same.

4. Defendant denies each and every allegation contained in paragraphs 9, 10, 11, 12 and 13 of the bill of complaint and therefore denies the same.

Further answering the bill of complaint, but without waiving its jurisdictional rights and under protest as to the jurisdiction of this Court over it, defendant upon information and belief says:

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5. That it does not manufacture, use or sell apparatus specified by the bill of particulars, of plaintiffs herein, as being the apparatus charged to infringe the respective Letters Patent in suit.

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6. That such apparatus was manufactured and sold defendant as manufactured under the patents in suit by a manufacturer thereof, duly licensed under said patents by the owners thereof or those having rights to grant such licenses.

7. That the apparatus alleged to infringe said Letters Patent were manufactured and sold to defendant by a licensee of the owners of said patents in suit as aforesaid with the knowledge, consent and/or acquiescence of the owners of said patents.

8. Upon information and belief, defendant denies that the alleged Letters Patent or either of them are good and valid in law, and on the

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Answer (Equity No. 50-175).

contrary asserts that they and each of them are void and invalid,—

- (a) because of want of patentable invention,
- (b) because of anticipation by prior publications, and
- (c) because of prior knowledge and/or public use.

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Defendant is not at present possessed of the particulars of the grounds of invalidity or particulars of the acts of invalidity, above specified, but begs leave to add the same hereto by proper amendment when such information and particulars are ascertained.

9. Defendant denies upon information and belief that the apparatus alleged to be an infringement embodies the alleged invention of said Letters Patent or either of them.

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WHEREFORE this defendant denies that plaintiffs are entitled to the relief prayed for or to any relief, and hence prays to be dismissed with its costs in this cause sustained.

GENERAL TALKING PICTURES CORPORATION,

By (s) DARBY & DARBY,

Attorneys.

Dated, New York, N. Y., August 7th, 1931.

**Defendant's Bill of Particulars (Equity No.
50-175).**

**UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.**

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,
vs.

Equity No.
50/175.

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GENERAL TALKING PICTURES CORPORATION,
Defendant.

Defendant, for its particulars of Paragraph 8 of its answer, as amended, says:

1. The patents and publications which will be relied upon to establish invalidity of the patents in suit are as follows:

45

As to Arnold Patent No. 1,329,283:

Stone, et al.	No. 884,110	granted Apr. 7, 1908
Reisz	" 1,234,489	" July 24, 1917
White	" 1,159,307	" Nov. 2, 1915
Langmuir	" 1,230,768	" Oct. 8, 1918
Langmuir	" 1,273,627	" July 23, 1918
Arnold	" 1,129,943	" Mar. 2, 1915
Seipt	" 1,012,456	" Dec. 19, 1911
Arnold	" 1,129,942	" Mar. 2, 1915
Colpitts	" 1,137,384	" Apr. 27, 1915
Heising	" 1,199,180	" Sept. 26, 1916
Arnold	" 1,128,280	" Feb. 16, 1915

*Defendant's Bill of Particulars (Equity
No. 50-175).*

2. The publications on which defendant will rely to establish the defense of want of patentable invention, in addition to the patents above enumerated, are:

	Colpitts	No. 1,129,959	granted Mar. 2, 1915
	Armstrong	" 1,113,149	" Oct. 6, 1914
	Schloemilch, et al.	" 1,087,892	" Feb. 17, 1914
	DeForest	" 1,177,848	" Apr. 4, 1916
47.	Arnold	" 1,114,845	" Oct. 27, 1914
	Nicolson	" 1,169,422	" Jan. 25, 1916

"The Wireless Telephone" by H. Grensbach,
Second Edition, published 1911 by The
Modern Publishing Company, 233 Fulton
Street, New York City.

3. The documentary evidence upon which the defendant will rely in support of its defense that the patentee was not the original and first inventor are the following patents:

48	DeForest	No. 1,375,447	granted Apr. 19, 1921
	Langmuir	" 1,558,436	" Oct. 20, 1925
	Colpitts	" 1,129,959	" Mar. 2, 1915

4. The patent on which defendant will rely in support of its defense of double patenting is:

Colpitts	No. 1,129,959	granted Mar. 2, 1915
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As to Arnold Patent No. 1,349,252:

1. The patents and publications which will be relied upon to establish invalidity of the patent are as follows:

*Defendant's Bill of Particulars (Equity
No. 50-175).*

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Arnold	No. 1,129,943	granted Mar.	2, 1915	
Pierce	" 1,127,371	" Feb.	2, 1915	
Stone, et al.	" 884,110	" Apr.	7, 1908	
Lowenstein	" 1,231,764	" July	3, 1917	
Langmuir	" 1,223,496	" Apr.	24, 1917	
Armstrong	" 1,113,149	" Oct.	6, 1914	
Schloemilch, et al.	" 1,087,892	" Feb.	17, 1914	
White	" 1,159,307	" Nov.	2, 1915	
Nichols	" 1,257,381	" Feb.	16, 1918	
Langmuir	" 1,280,768	" Oct.	8, 1918	50
Langmuir	" 1,273,627	" July	23, 1918	
Colpitts	" 1,137,384	" Apr.	27, 1915	

Article by E. H. Armstrong "Operating Features of the Audion," Electrical World of December 12, 1914, pages 1149-1152.

2. The publications on which defendant will rely to establish the defense of want of patentable invention, in addition to the patents above enumerated, are:

DeForest	No. 1,201,272	granted Oct.	17, 1916	51
DeForest	" 1,177,848	" Apr.	4, 1916	
Reisz	" 1,418,022	" May	30, 1922	
Arnold	" 1,114,845	" Oct.	27, 1914	
Colpitts	" 1,129,959	" Mar.	2, 1915	
Arnold	" 1,129,942	" Mar.	2, 1915	
British	2059/14			

3. The documentary evidence upon which the defendant will rely in support of its defense that the patentee was not the original and first inventor are the following patents:

*Defendant's Bill of Particulars (Equity
No. 50-175).*

DeForest	No. 1,375,447	granted Apr. 19, 1921
White	" 1,617,974	" Feb. 15, 1927
Hewitt	" 1,393,369	" Oct. 11, 1921

4. The patent on which defendant will rely in support of its defense of double patenting is:

Arnold	No. 1,329,283	granted Jan. 27, 1920
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As to Arnold Patent No. 1,448,550:

1. The patents and publications which will be relied upon to establish invalidity of the patents in suit are as follows:

Colpitts	No. 1,129,959	granted Mar. 2, 1915
Langmuir	" 1,223,496	" Apr. 24, 1917
Lowenstein	" 1,231,764	" July 3, 1917
VanDer Bijl	" 1,350,752	" Aug. 24, 1920
DeForest	" 1,221,035	" Apr. 3, 1917
Schloemilch, <i>et al.</i>	" 1,087,892	" Feb. 17, 1914
DeForest	" 1,177,848	" Apr. 4, 1916
54 White	" 1,159,307	" Nov. 2, 1915
Meissner	" 1,170,552	" Feb. 8, 1916
Von Areo, <i>et al.</i>	" 1,314,102	" Aug. 26, 1919
Langmuir	" 1,280,768	" Apr. 8, 1918
Langmuir	" 1,273,627	" July 23, 1918
DeForest	" 1,377,405	" May 10, 1921
Alexanderson	" 1,173,079	" Feb. 22, 1916
Heising	" 1,199,180	" Sept. 26, 1916

2. The publications on which defendant will rely to establish the defense of want of patentable invention, in addition to the patents above enumerated, are:

Defendant's Bill of Particulars (Equity)
No. 50-175).

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Stone, et al.	No. 884,110	granted Apr. 7, 1908
Colpitts	" Re-14,380	" Oct. 23, 1917
Lindridge	" 1,047,956	" Dec. 24, 1912
Richards	" 1,103,688	" July 14, 1914

3. The documentary evidence upon which the defendant will rely in support of its defense that the patentee was not the original and first inventor are the following:

White	No. 1,617,974	granted Feb. 15, 1927
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As to Arnold Patent No. 1,520,994:

The patents and publications which will be relied upon to establish invalidity of the patent is as follows:

Colpitts	No. 1,129,959	granted Mar. 2, 1915
Stone, et al.	" 884,110	" Apr. 7, 1908
Langmuir	" 1,223,496	" Apr. 27, 1917
Colpitts	" Re-14,380	" Oct. 23, 1917
Lindridge	" 1,047,956	" Dec. 24, 1912
Lowenstein	" 1,231,764	" July 3, 1917
VanDer Bijl	" 1,350,752	" Aug. 24, 1920
DeForest	" 1,221,035	" Apr. 3, 1917
Schloemilch, et al.	" 1,087,892	" Feb. 17, 1914
DeForest	" 1,177,848	" Apr. 4, 1916
White	" 1,159,507	" Nov. 2, 1915
Von Arco	" 1,314,102	" Aug. 26, 1919
Langmuir	" 1,280,768	" Oct. 8, 1918
DeForest	" 1,377,405	" May 10, 1921
Arnold	" 1,448,550	" Mar. 13, 1923

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2. The publications on which defendant will rely to establish the defense of want of patent-

*Defendant's Bill of Particulars (Equity
No. 50-175).*

able invention, in addition to the patents above enumerated, are:

	Alexanderson	No. 1,340,101	granted May 11, 1920
	Meissner	" 1,170,552	" Feb. 8, 1918
	DeForest	" 1,201,272	" Oct. 17, 1916
	Logwood	" 1,218,195	" Mar. 6, 1917
	Campbell	" 1,227,113	" May 22, 1917
	Langmuir	" 1,273,627	" July 23, 1918
59	DeForest	" 979,276	" Dec. 20, 1910
	DeForest *	" 1,375,447	" Apr. 19, 1921
	French Patent of Addition	" 13,726/11	
	British Patent	" 6,101/08	

3. The documentary evidence upon which the defendant will rely in support of its defense that the patentee was not the original and first inventor is:

	White	No. 1,617,974	granted Feb. 15, 1927
60			

4. The patent on which defendant will rely in support of its defense of double patenting is:

	Arnold	No. 1,448,550	granted Mar. 13, 1923
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GENERAL TALKING PICTURES CORPORATION,
By DARBY & DARBY,
Attorneys for Defendant.

Dated: New York, N. Y.,
November 13, 1933.

SAMUEL E. DARBY, JR.,
Counsel for Defendant.

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**Stipulation and Order Amending Answer
(Equity No. 50-175).**

UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,
Plaintiffs,
vs.

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Equity No.
50-175.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

It is hereby stipulated that the answer in this cause be amended by the cancellation of subparagraphs (a), (b) and (c) to Paragraph 8 thereof, and the substitution therefor of the following:

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- (a) because the alleged invention of said patents was described in printed publications of the United States and countries foreign to the United States before the alleged invention of said patents or more than two years prior thereto,
- (b) because the said patents disclosed no patentable invention or inventions as distinguished from mechanical skill and natural progress of the art in view of the state of

**64 *Stipulation and Order Amending Answer
(Equity No. 50-175).***

the art at the time the alleged inventions were made,

- (c) because the said patentees were not the original and first inventors of the alleged inventions of said patents,
- (d) because the claims of the patents in suit are directed to inventions different from the alleged inventions at the time the applications for said patents were filed and that said claims were first made more than two years subsequent to publication of the said inventions, and
- (e) because of double patenting.

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HENRY R. ASHTON,
Counsel for Plaintiffs.

New York, N. Y., November 14, 1933.

66

DARBY & DARBY,
Counsel for Defendant.

New York, N. Y., November 13, 1933.

It is so ordered.

JNO. C. KNOX,
U. S. D. J.

Dated: 11/16/33

Bill of Complaint (Equity No. 50-177).

**IN THE
UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.**

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

against

GENERAL TALKING PICTURES CORPORATION,
Defendant.

In Equity,
on Letters Patent
1,231,764.
1,426,754.

To THE HONORABLE THE JUDGES OF THE DISTRICT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK:

Plaintiffs, by this Bill of Complaint, allege:

1. That plaintiff, Western Electric Company, Incorporated, is a corporation duly organized and existing under and by virtue of the laws of the State of New York and is a citizen of said State; that plaintiff, Electrical Research Products, Inc., is a corporation duly organized and existing under and by virtue of the laws of the State of Delaware and is a citizen of said State; that plaintiff, American Telephone and Telegraph Company, is a corporation duly organized and existing under and by virtue of the laws of

Bill of Complaint (Equity No. 50-177).

the State of New York and is a citizen of said State; that plaintiff, Western Electric Company, Incorporated, is a subsidiary of said plaintiff, American Telephone and Telegraph Company, more than 98% of its corporate stock being owned by said Company; and that plaintiff, Electrical Research Products, Inc., is a subsidiary of plaintiff, Western Electric Company, Incorporated, its entire corporate stock being owned by said Company.

2. That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation existing under and by virtue of the laws of the State of New York and is a citizen and resident of said State.

3. That this is a suit in equity arising under the patent laws of the United States for infringement of the following Letters Patent:

	<i>Inventor</i>	<i>Patent No.</i>	<i>Date of Issue</i>	<i>Filing Date of Application</i>
72	F. Lowenstein	1,231,764	July 3, 1917	Apr. 24, 1912
	R. C. Mathes	1,426,754	Aug. 22, 1922	Oct. 23, 1916

4. Plaintiffs are informed and believe and therefore aver, with respect to each of the patents in the foregoing list: That the inventor therein named was, prior to the filing date of the application therefor as above given, the first, original and sole inventor of the improvements and inventions covered thereby, which improvements and inventions were not known or used by others in this country before his invention or discovery thereof and were not patented or

described in any printed publication in this or any foreign country before his invention or discovery thereof or more than two years prior to said filing date, and were not in public use or on sale in this country for more than two years prior to said filing date, and had not been abandoned, and had not been patented nor caused to be patented by himself or his legal representatives or assigns in any foreign country upon an application filed more than twelve months prior to said filing date; that on said filing date he duly filed in the United States Patent Office an application for Letters Patent for said improvements and inventions; and that prior to the said date of issue all of the requirements of the statutes of the United States then in force had been duly complied with.

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5. That the said Lowenstein Patent No. 1,231,764, was duly issued to Fritz Lowenstein, his heirs and assigns; and that by an instrument in writing duly executed on or about September 5, 1918, and recorded in the United States Patent Office, the said Fritz Lowenstein duly assigned and transferred to plaintiff, American Telephone and Telegraph Company, the entire right, title and interest in and to said patent.

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6. That the said inventor, Mathes, having assigned to the Western Electric Company, Incorporated, his entire right, title and interest in and to the application filed by him October 23, 1916, as aforesaid and the inventions and improvements therein disclosed, said Patent No. 1,426,754, was duly issued to plaintiff, Western Electric Company, Incorporated, its successors

and assigns; that by an instrument in writing duly executed and delivered on or about November 11, 1922, and recorded in the United States Patent Office, said Western Electric Company, Incorporated, duly assigned and transferred to plaintiff, American Telephone and Telegraph Company the entire right, title and interest in and to the said patent.

7. That plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are, and at the time of the infringement herein complained of were, engaged in making, selling, leasing, installing and using apparatus for recording sound and apparatus for reproducing sound from records thereof by virtue of licenses from plaintiff, American Telephone and Telegraph Company, under the patents aforesaid for certain purposes, including the field of use of the infringement complained of; and that

77 by an instrument in writing executed and delivered on or about the 7th day of May, 1929, said American Telephone and Telegraph Company confirmed the aforesaid licenses to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products Inc., and assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., all its rights under or arising from said patents to exclude others from the manufacture, sale, lease, installation and/or use of apparatus, devices, systems or methods for certain purposes, including the field of the infringement herein complained of; and also assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Re-

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search Products, Inc., all claims which had arisen, or which might thereafter arise, out of the infringement of the aforesaid patents within the field of said purposes and the rights for their own benefit to bring suit against any infringer in said field.

8. And plaintiffs pray that the aforesaid Letters Patent, instruments, assignments and agreements in writing may be deemed and taken as a part of this Bill of Complaint and plaintiffs ask leave to refer to the originals of the same or duly authenticated copies thereof, all of which they stand ready in court to produce.

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9. That, by virtue of the assignments aforesaid, plaintiff, American Telephone and Telegraph Company, is, and has, at all times since the date of said assignments to said Company, including the time of the infringement herein complained of, been the owner of said Letters Patent No. 1,231,764, and 1,426,754, and plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are entitled to sue jointly with plaintiff, American Telephone and Telegraph Company, for injunctive relief for the infringement of said patents herein complained of and to recover profits and/or damages arising out of said infringement.

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10. That plaintiffs have expended large sums of money in making the inventions of said Letters Patent profitable to themselves and their licensees and useful to the public; that they and their licensees have made and sold or caused to be made and sold large number of systems, ap-

82 *Bill of Complaint (Equity No. 50-177).*

paratus and electrical amplifiers embodying said inventions and improvements, for the purpose, among others, of the electrical reproduction of sound, from records thereof in accompaniment with motion pictures, said systems, apparatus and electrical amplifiers having had affixed thereto the word "Patented" together with the days and years said respective Letters Patent applicable thereto were granted and/or the numbers thereof as provided by Section 4900 of the Revised Statutes of the United States; and that the inventions and improvements of said Letters Patent are of great value, importance, benefit and advantage to the public.

11. That, as plaintiffs are informed and believe and therefore aver, said Letters Patent No. 1,231,764 and No. 1,426,754, have been in litigation in a suit in the United States District Court for the Southern District of New York brought by the Radio Corporation of America and others (being licensees of said American Telephone and Telegraph Company, plaintiff herein) as plaintiffs, against J. H. Bunnell & Company, Inc., and others as defendants; that after trial and decision in said suit an interlocutory decree was entered therein on or about June 5, 1928, sustaining claims 1 and 7 of said Patent No. 1,231,764, and claim 8 of said Patent No. 1,426,754; that the aforesaid decree is now in full force and effect as will more fully appear by reference to the records in said suit to which plaintiffs pray leave to refer.

12. That the inventions of said Letters Patent are capable of conjoint use in one and the

Bill of Complaint (Equity No. 50-177).

same unitary structure, device, amplifier or equipment and have been and now are being so used by the defendant in the infringement complained of herein.

13. That, as plaintiffs, are informed and believe and therefore aver, defendant, without a license under either of said several Letters Patent, and in violation and infringement of each of said Letters Patent, has, within the last six years and prior to the filing of this Bill of Complaint and subsequent to the issue of each of said patents and to the assignments thereof to the plaintiff, American Telephone and Telegraph Company unlawfully and wrongfully made or caused to be made, sold and used within the United States devices, apparatus, systems, structures, amplifiers and arrangements including arrangements for commercial use in the electrical reproduction of sound from records thereof in accompaniment with motion pictures, each and all containing the inventions and improvements of each of said Letters Patent or substantial, material and vital parts thereof and each and all infringing upon and/or contributing to the infringement of each of said Letters Patent and upon the aforesaid rights of plaintiffs under each of said Letters Patent and the claims thereof.

14. That, as plaintiffs are informed and believe and therefore aver, defendant has derived and received and will derive and receive from the infringement complained of large gains, profits and advantages, but to what amount plaintiffs are ignorant and cannot set forth; that by reason of said infringement plaintiffs have been and

will be deprived of and prevented from receiving, if such infringement is not forthwith restrained by this court, gains, profits and advantages to which plaintiffs are lawfully entitled and which they would have derived and received and would now be deriving and receiving but for the aforesaid infringement; that by reason of the aforesaid infringement plaintiffs have been irreparably injured and have sustained losses and damages therefrom; that unless the infringement
89 is immediately restrained further immediate irreparable injury, loss and damage will be caused to the rights of plaintiffs.

15. That, as plaintiffs are informed and believe and therefore aver, defendant prior to the commencement of this suit had full knowledge of said several Letters Patent and the aforesaid infringement thereof but notwithstanding such knowledge is now continuing and threatening to continue said infringement.

WHEREFORE, plaintiffs pray:

1. That a perpetual injunction may be issued enjoining and restraining said defendant and its officers, associates, agents, attorneys, servants, workmen, employees, and each of them, and all those in privity therewith, from in any way infringing directly or indirectly or contributing to the infringement of the said Letters Patent or any of the claims thereof.

2. That a preliminary injunction of the same tenor and effect as the perpetual injunction hereinbefore prayed for may issue against said de-

fendant pending the determination of this suit and until further order of this court.

3. That defendant be ordered and decreed to deliver to plaintiffs each and all of said infringing devices, apparatus, amplifiers or arrangements which it has in its possession or under its control or that the same may be destroyed or that they may be delivered into court or be impounded by the court for such final disposition as to the court may seem just or proper.

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4. That defendant be required to account for and pay over to the plaintiffs such gains and profits as have accrued or risen or been earned or received by the said defendant and all such gains and profits as would have accrued to plaintiffs but for the unlawful doings of said defendant, and all damages plaintiffs have sustained thereby, and that the Court will assess the same or cause them to be assessed under its direction and will increase the same in its discretion as provided by law.

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5. That defendant may be decreed to pay the costs, charges, and disbursements in this suit and that plaintiffs may have such other and further relief as the circumstances and the equity of the case may require.

Answer under oath is hereby expressly waived.

WESTERN ELECTRIC COMPANY, INCOR-
PORATED,

By (S) GEO. C. PRATT,
Vice President.

ELECTRICAL RESEARCH PRODUCTS, INC.,

By (S) J. J. LYNG,
Vice President.

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Bill of Complaint (Equity No. 50-177).

AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,

By (S) CHARLES M. BRACELEN,
Vice President.

CHARLES NEAVE,

Solicitor and of Counsel for Plaintiffs.

(S) FRANKLIN T. WOODWARD,

(S) WILLIAM R. BALLARD,

95 of Counsel for Plaintiffs.

State of New York, }
County of New York, }
ss.:

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CHARLES M. BRACELEN, being duly sworn deposes and says that he is Vice President of the American Telephone and Telegraph Company, one of the plaintiffs named in the foregoing Bill of Complaint, and that he has read the same and knows the contents thereof, and that the same is true to his own knowledge except as to the matters therein stated to be alleged on information and belief and as to these matters he believes them to be true; that the reason why his verification is not made by said plaintiff personally is that this plaintiff is a corporation.

(S) CHARLES M. BRACELEN.

Sworn to before me this
5th day of September, 1929.

(S) J. A. GATELY,
Notary Public.

**Amendment to Bill of Complaint (Equity No.
50-177).**

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UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY; INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

Equity No.

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50-177.

GENERAL TALKING PICTURES CORPORATION,

Defendant.

Now come the plaintiffs and, in accordance with the provisions of Equity Rule 28, amend the bill of complaint herein in the following respects:

1. Paragraph 2 of the bill of complaint is hereby amended to read as follows:

99

"That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation of the State of Delaware, and has a regular and established place of business within the Southern District of New York in which District and elsewhere within the United States it has committed the acts of infringement hereinafter complained of."

2. Paragraph 13 of the bill of complaint is hereby amended by inserting in line 9 of the said

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Answer (Equity No. 50-177).

paragraph after the word "within" the following:

the Southern District of New York and elsewhere in

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WESTERN ELECTRIC COMPANY, INCORPORATED,
ELECTRICAL RESEARCH PRODUCTS, INC.,
AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,

By CHARLES NEAVE,
Solicitor for Plaintiffs.

Answer (Equity No. 50-177).

UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.

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WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,
Plaintiffs,

Equity No.
50/177.

vs.

GENERAL TALKING PICTURES
CORPORATION,
Defendant.

For answer to the bill of complaint herein or to as much thereof as defendant is advised is

material or required to be answered, defendant says:

1. Defendant denies each and every allegation contained in paragraph 2 of the bill of complaint and to the contrary asserts that it is a corporation of the State of Delaware, has committed no acts of infringement within the Southern District of New York, and denies that this Court has jurisdiction over it.

2. Defendant denies each and every allegation contained in paragraphs 4, 5, 6 and 7 of the bill of complaint except that it admits having seen what purported to be printed copies of the patents specified in paragraph 3 of the bill of complaint.

3. Defendant has no information sufficient upon which to form a belief as to the matters alleged in paragraph 9 of the bill of complaint and therefore denies the same.

4. Defendant denies each and every allegation contained in paragraphs 10, 12, 13, 14 and 15 of the bill of complaint and therefore denies the same.

Further answering the bill of complaint, but without waiving its jurisdictional rights and under protest as to the jurisdiction of this Court over it, defendant upon information and belief says:

5. That it does not manufacture, use or sell apparatus specified by the bill of particulars of plaintiffs herein as being the apparatus charged to infringe the respective Letters Patent in suit.

Answer (Equity No. 50-177).

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6. That such apparatus was manufactured and sold defendant as manufactured under the patents in suit, by a manufacturer thereof, duly licensed under said patents by the owners thereof, or those having rights to grant such licenses.

7. That the apparatus alleged to infringe said Letters Patent were manufactured and sold to defendant by a licensee of the owners of said patent in suit as aforesaid with the knowledge, consent and/or acquiescence of the owners of said patent.

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8. Upon information and belief, defendant denies that the alleged Letters Patent or either of them are good and valid in law, and on the contrary asserts that they and each of them are void and invalid,

- (a) because of want of patentable invention,
- (b) because of anticipation of prior publications, and
- (c) because of prior knowledge and/or public use.

Defendant is not at present possessed of the particulars of the grounds of invalidity or particulars of the acts of invalidity, above specified, but begs leave to add the same hereto by proper amendment when such information and particulars are ascertained.

9. Defendant denies upon information and belief that the apparatus alleged to be an infringement embodies the alleged invention of said Letters Patent or either of them.

Answer (Equity No. 50-177).

10. As to the matter set forth in paragraph 11 of the said bill of complaint, defendant admits the allegations therein contained, but asserts the allegations therein are incomplete in that said Lowenstein patent No. 1,231,764, has been adjudged to be invalid in law by the United States District Court for the Eastern District of New York in a decision recently rendered in that Court brought by the plaintiffs herein against one, Sol Wallerstein, identified in that Court as Equity No. 7.

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WHEREFORE, this defendant denies that plaintiffs are entitled to the relief prayed for or to any relief, and hence prays to be dismissed with its costs in this cause sustained.

GENERAL TALKING PICTURES CORPORATION,
By DARBY & DARBY,
Attorneys.

Dated, New York, N. Y., August 7th, 1931.

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Defendant's Bill of Particulars (Equity No.
50-177).

UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

113

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY, Plaintiffs,

Equity No.
50/177.

vs.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

Defendant, for its particulars of Paragraph 8
of its answer, as amended, says:

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1. The patents and publications which will be relied upon to establish invalidity of the patents in suit are as follows:

As to Lowenstein Patent No. 1,231,764 (all claims except claim 3):

Weintraub, et al.	No. 921,930	granted May 18, 1909
VonLieben, et al.	" 1,038,910	" Sept. 17, 1912
DeForest	" 841,387	" Jan. 15, 1907
Stone, et al.	" 884,110	" Apr. 7, 1908
DeForest	" 879,532	" Feb. 18, 1908
DeForest	" 995,126	" June 13, 1911
French Patent of		
Addition	" 13,726/11	

*Defendant's Bill of Particulars (Equity
No. 50-177).*

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As to Mathes Patent No. 1,426,754:

Leisz	No. 1,418,022	granted May 30, 1922	
Leisz	" 1,234,489	" July 24, 1917	
DeForest	" 979,276	" Dec. 20, 1910	
Heissner	" 1,170,552	" Feb. 8, 1916	
Arnold	" 1,129,943	" Mar. 2, 1915	
White	" 1,195,632	" Aug. 22, 1916	
rickard	" 1,128,817	" Feb. 16, 1915	
onLieben, et al.	" 1,038,910	" Sept. 17, 1912	
olpitts, et al.	" 1,388,450	" Aug. 23, 1921	116
erman Patent	" 217,073		
erman Patent	" 249,149		
ritish Patent	" 1,482/11		

2. The instances of the prior art on which defendant will rely to establish the defense of want of patentable invention are the patents above enumerated in addition to the following:

olpitts	No. 1,137,384	granted Apr. 27, 1915	
onLieben, et al.	" Re-13,779	" July 21, 1914	
leising	" 1,199,180	" Sept. 26, 1916	
ierce	" 1,127,371	" Feb. 2, 1915	
angmuir	" 1,223,496	" Apr. 24, 1917	
angmuir	" 1,273,627	" July 23, 1918	
rnold	" 1,129,942	" Mar. 2, 1915	
erman Patent	No. 268,460		
ritish Patent	" 13,248/14		

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GENERAL TALKING PICTURES CORPORATION,
By DARBY & DARBY,
Attorneys for Defendant.

Dated: New York, N. Y.,
November 13, 1933.

SAMUEL E. DARBY, JR.,
Counsel for Defendant.

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**Stipulation and Order Amending Answer
(Equity No. 50-177).**

**UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.**

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WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

Equity No.
50-177.

vs.

GENERAL TALKING PICTURES CORPORATION,

Defendant.

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It is hereby stipulated that the answer in this cause be amended by the cancellation of subparagraphs (a), (b) and (c) to Paragraph 8 thereof, and the substitution therefor of the following:

(a) because the alleged invention of said patents was described in printed publications of the United States and countries foreign to the United States before the alleged invention of said patents or more than two years prior thereto,

(b) because the said patents disclosed no patentable invention or inventions as distinguished from mechanical skill and natural progress of the art in view of the state of the art at the time the alleged inventions were made,

*Stipulation and Order Amending Answer
(Equity No. 50-177).*

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- (c) because the said patentees were not the original and first inventors of the alleged inventions of said patents,
- (d) because the claims of the patents in suit are directed to inventions different from the alleged inventions at the time the applications for said patents were filed and that said claims were first made more than two years subsequent to publication of the said inventions, and
- (e) because of double patenting.

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HENRY R. ASHTON,
Counsel for Plaintiffs.

New York, N. Y., November 14, 1933.

DARBY & DARBY,
Counsel for Defendant.

New York, N. Y., November 13, 1933.

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It is so ordered.

JNO^y C. KNOX,
U. S. D. J.

Dated: 11/16/33

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Bill of Complaint (Equity No. 50-178).

IN THE
UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

125 Plaintiffs,
against.

In Equity,
on Letters Patent
1,129,942,
1,403,475,
1,465,332.

GENERAL TALKING PICTURES CORPORATION;
Defendant.

TO THE HONORABLE THE JUDGES OF THE DISTRICT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK:

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Plaintiffs, by this Bill of Complaint, allege:

1. That plaintiff, Western Electric Company, Incorporated, is a corporation duly organized and existing under and by virtue of the laws of the State of New York and is a citizen of said State; that plaintiff, Electrical Research Products, Inc., is a corporation duly organized and existing under and by virtue of the laws of the State of Delaware and is a citizen of said State; that plaintiff, American Telephone and Telegraph Company, is a corporation duly organized and existing under and by virtue of the laws of

Bill of Complaint (Equity No. 50-178).

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the State of New York and is a citizen of said State; that plaintiff, Western Electric Company, Incorporated, is a subsidiary of said plaintiff, American Telephone and Telegraph Company, more than 98% of its corporate stock being owned by said Company; and that plaintiff, Electrical Research Products, Inc., is a subsidiary of plaintiff, Western Electric Company, Incorporated, its entire corporate stock being owned by said Company.

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2. That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation existing under and by virtue of the laws of the State of New York and is a citizen and resident of said State.

3. That this is a suit in equity arising under the patent laws of the United States for infringement of the following Letters Patent:

<i>Inventor</i>	<i>Patent No.</i>	<i>Date of Issue</i>	<i>Filing Date of Application</i>	
H. D. Arnold	1,129,942	Mar. 2, 1915	May 28, 1914	129
H. D. Arnold	1,403,475	Jan. 17, 1922	Nov. 11, 1920	
H. D. Arnold	1,465,332	Aug. 21, 1923	Sept. 3, 1915	

4. Plaintiffs are informed and believe and therefore aver that with respect to each of the patents in the foregoing list, said Arnold was, prior to the filing date of the application therefor as above given, the first, original and sole inventor of the improvements and inventions covered thereby, which improvements and inventions were not known or used by others in this country before his invention or discovery there-

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Bill of Complaint (Equity No. 50-178).

of and were not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof or more than two years prior to said filing date; and were not in public use or on sale in this country for more than two years prior to said filing date, and had not been abandoned, and had not been patented nor caused to be patented by himself or his legal representatives or assigns in any foreign country upon an application filed 131 more than twelve months prior to said filing date; that on said filing date he duly filed in the United States Patent Office an application for Letters Patent for said improvements and inventions; and that prior to the said date of issue all the requirements of the statutes of the United States then in force had been duly complied with.

5. That said Arnold, having assigned to the Western Electric Company, a corporation of Illinois, his entire right, title and interest in and 132 to the application filed by him on May 28, 1914, as aforesaid, and the inventions and improvements therein disclosed, said Patent No. 1,129,942 was duly issued to said Western Electric Company, its successors and assigns; and that by an instrument in writing duly executed and delivered on or about November 24, 1915, and recorded in the United States Patent Office, said Western Electric Company duly assigned and transferred to plaintiff, Western Electric Company, Incorporated, the entire right, title and interest in and to the said patent; that by an instrument in writing duly executed and delivered on or about December 8, 1915, and re-

corded in the United States Patent Office, the plaintiff, Western Electric Company, Incorporated, duly assigned and transferred to plaintiff, American Telephone and Telegraph Company, the entire right, title and interest in and to said patent.

6. That said Arnold, having assigned to the Western Electric Company, Incorporated, his entire right, title and interest in and to the applications filed by him on November 11, 1920, and September 3, 1915, as aforesaid, and the inventions and improvements therein disclosed, said Patents No. 1,403,475 and No. 1,465,332 were duly issued to plaintiff, Western Electric Company, Incorporated, its successors and assigns; that by instruments in writing duly executed and delivered on or about December 14, 1922 and February 5, 1924, respectively, and recorded in the United States Patent Office, said Western Electric Company, Incorporated, duly assigned and transferred to plaintiff, American Telephone and Telegraph Company, the entire right, title and interest in and to the said patents. 135

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7. That plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are, and at the time of the infringement herein complained of were, engaged in making, selling, leasing, installing and using apparatus for recording sound and apparatus for reproducing sound from records thereof by virtue of licenses from plaintiff, American Telephone and Telegraph Company, under the patents aforesaid for certain purposes, including the field of use of the infringement complained of; and that by

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Bill of Complaint (Equity No. 50-178).

an instrument in writing executed and delivered on or about the 7th day of May, 1929, said American Telephone and Telegraph Company confirmed the aforesaid licenses to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., and assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., all its rights under or arising from said patents to exclude others from the manufacture, sale, lease, installation and/or use of apparatus, devices, systems or methods for certain purposes, including the field of the infringement herein complained of; and also assigned and set over to plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., all claims which had arisen, or which might thereafter arise, out of the infringement of the aforesaid patents within the field of said purposes and the rights for their own benefit to bring suit against any infringer in said field.

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8. And plaintiffs pray that the aforesaid Letters Patent, instruments, assignments and agreements in writing may be deemed and taken as a part of this Bill of Complaint and plaintiffs ask leave to refer to the originals of the same or duly authenticated copies thereof, all of which they stand ready in court to produce.

9. That, by virtue of the assignments aforesaid, plaintiff, American Telephone and Telegraph Company, is, and has, at all times since the date of said assignments to said Company, including the time of the infringement herein

Bill of Complaint (Equity No. 50-178).

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complained of, been the owner of said Letters Patent No. 1,129,942, No. 1,403,475 and No. 1,465,332, and plaintiffs, Western Electric Company, Incorporated, and Electrical Research Products, Inc., are entitled to sue jointly with plaintiff, American Telephone and Telegraph Company, for injunctive relief for the infringement of said patents herein complained of and to recover profits and/or damages arising out of said infringement.

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10. That plaintiffs have expended large sums of money in making the inventions of said Letters Patent profitable to themselves and their licensees and useful to the public; that they and their licensees have made and sold or caused to be made and sold large numbers of systems, apparatus and electrical amplifiers embodying said inventions and improvements, for the purpose, among others, of the electrical reproduction of sound from records thereof in accompaniment with motion pictures, said systems, apparatus and electrical amplifiers having had affixed thereto the word "Patented" together with the days and years said respective Letters Patent applicable thereto were granted and/or the numbers thereof as provided by Section 4900 of the Revised Statutes of the United States; and that the inventions and improvements of said Letters Patent are of great value, importance, benefit and advantage to the public.

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11. That the inventions of said Letters Patent are capable of conjoint use in one and the same unitary structure, device, amplifier or equipment and have been and now are being so used

by the defendant in the infringement complained of herein.

12. That, as plaintiffs are informed and believe and therefore aver, defendant, without a license under either of said several Letters Patent, and in violation and infringement of each of said Letters Patent, has, within the last six years and prior to the filing of this Bill of Complaint and subsequent to the issue of each of

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said patents and to the assignments thereof to the plaintiff, American Telephone and Telegraph Company, unlawfully and wrongfully made or caused to be made, sold and used within the United States devices, apparatus, systems, structures, amplifiers and arrangements including arrangements for commercial use in the electrical reproduction of sound from records thereof, in accompaniment with motion pictures, each and all containing the inventions and improvements of each of said Letters Patent or substantial, material and vital parts thereof and each and all

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infringing upon and/or contributing to the infringement of each of said Letters Patent and upon the aforesaid rights of plaintiffs under each of said Letters Patent and the claims thereof.

13. That, as plaintiffs are informed and believe and therefore aver, defendant has derived and received and will derive and receive from the infringement complained of large gains, profits and advantages, but to what amount plaintiffs are ignorant and cannot set forth; that by reason of said infringement plaintiffs have been and will be deprived of and prevented from re-

ceiving, if such infringement is not forthwith restrained by this court, gains, profits and advantages to which plaintiffs are lawfully entitled and which they would have derived and received and would now be deriving and receiving but for the aforesaid infringement; that by reason of the aforesaid infringement plaintiffs have been irreparably injured and have sustained losses and damages therefrom; that unless the infringement is immediately restrained further immediate irreparable injury, loss and damage will be caused to the rights of plaintiffs.

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14. That, as plaintiffs are informed and believe and therefore aver, defendant prior to the commencement of this suit had full knowledge of said several Letters Patent and the aforesaid infringement thereof but notwithstanding such knowledge is now continuing and threatening to continue said infringement.

WHEREFORE plaintiffs pray:

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1. That a perpetual injunction may be issued enjoining and restraining said defendant and its officers, associates, agents, attorneys, servants, workmen, employees, and each of them, and all those in privity therewith, from in any way infringing directly or indirectly or contributing to the infringement of the said Letters Patent or any of the claims thereof.

2. That a preliminary injunction of the same tenor and effect as the perpetual injunction hereinbefore prayed for may issue against said defendant pending the determination of this suit and until further order of this court.

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Bill of Complaint (Equity No. 50-178).

3. That defendant be ordered and decreed to deliver to plaintiffs each and all of said infringing devices, apparatus, amplifiers or arrangements which it has in its possession or under its control or that the same may be destroyed or that they may be delivered into court or be impounded by the court for such final disposition as to the court may seem just and proper.

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4. That defendant be required to account for and pay over to plaintiffs such gains and profits as have accrued or risen or been earned or received by the said defendant and all such gains and profits as would have accrued to plaintiffs but for the unlawful doings of said defendant, and all damages plaintiffs have sustained thereby, and that the Court will assess the same or cause them to be assessed under its direction and will increase the same in its discretion as provided by law.

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5. That defendant may be decreed to pay the costs, charges and disbursements in this suit and that plaintiffs may have such other and further relief as the circumstances and the equity of the case may require.

Answer under oath is hereby expressly waived.

WESTERN ELECTRIC COMPANY, INCOR-
PORATED,

By (S) GEO. C. PRATT,
Vice President.

ELECTRICAL RESEARCH PRODUCTS, INC.,

By (S) J. J. LYNG,
Vice President.

Bill of Complaint (Equity No. 50-178).

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**AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,**

By (S) CHARLES M. BRACELEN,
Vice President.

CHARLES NEAVE,
Solicitor and of Counsel for Plaintiffs.

(S) FRANKLIN T. WOODWARD,
(S) WILLIAM R. BALLARD,
of Counsel for Plaintiffs.

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State of New York, }
County of New York, }^{ss.}:

CHARLES M. BRACELEN, being duly sworn, deposes and says that he is Vice President of the American Telephone and Telegraph Company, one of the plaintiffs named in the foregoing Bill of Complaint, and that he has read the same and knows the contents thereof, and that the same is true to his own knowledge except as to the matters therein stated to be alleged on information and belief and as to these matters he believes them to be true; that the reason why this verification is not made by said plaintiff personally is that this plaintiff is a corporation.

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(S) CHARLES M. BRACELEN.

Sworn to before me this
12th day of September, 1929.

(S) H. W. HOLLISBERG,
Notary Public.

**154 Amendment to Bill of Complaint (Equity No.
50-178).**

**UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.**

**WESTERN ELECTRIC COMPANY, IN-
CORPORATED, ELECTRICAL RE-
SEARCH PRODUCTS, INC., and
AMERICAN TELEPHONE AND
TELEGRAPH COMPANY,**

Plaintiffs,

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vs.

Equity No.
50-178.

**GENERAL TALKING PICTURES
CORPORATION,**

Defendant.

Now come the plaintiffs and, in accordance with the provisions of Equity Rule 28, amend the bill of complaint herein in the following respects:

**156 1. Paragraph 2 of the bill of complaint is
hereby amended to read as follows:**

“That, as plaintiffs are informed and believe and therefore aver, defendant is a corporation of the State of Delaware, and has a regular and established place of business within the Southern District of New York in which District and elsewhere within the United States it has committed the acts of infringement hereinafter complained of.”

**2. Paragraph 12 of the bill of complaint is
hereby amended by inserting in line 8 of the
said paragraph after the word “within” the
following:**

Answer (Equity No. 50-178).

the Southern District of New York and elsewhere in

WESTERN ELECTRIC COMPANY, INCORPORATED,

ELECTRICAL RESEARCH PRODUCTS, INC.,
AMERICAN TELEPHONE AND TELEGRAPH
COMPANY,

By CHARLES NEAVE,
Solicitor for Plaintiffs. 158

Answer (Equity No. 50-178).

UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

Equity No.
50-178.

For answer to the bill of complaint herein or to as much thereof as defendant is advised is

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Answer (Equity No. 50-178).

material or required to be answered, defendant says:

1. Defendant denies each and every allegation contained in paragraph 2 of the bill of complaint and to the contrary asserts that it is a corporation of the State of Delaware; has committed no acts of infringement within the Southern District of New York, and denies that this Court has jurisdiction over it.

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2. Defendant denies each and every allegation contained in paragraphs 4, 5, 6 and 7 of the bill of complaint except that it admits having seen what purported to be printed copies of the patents specified in paragraph 3 of the bill of complaint.

3. Defendant has no information sufficient upon which to form a belief as to the matters alleged in paragraph 9 of the bill of complaint and therefore denies the same.

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4. Defendant denies each and every allegation contained in paragraphs 10, 11, 12, 13 and 14 of the bill of complaint and therefore denies the same.

Further answering the bill of complaint, but without waiving its jurisdictional rights and under protest as to the jurisdiction of this Court over it, defendant upon information and belief says:

5. That it does not manufacture, use or sell apparatus specified by the bill of particulars of plaintiffs herein as being the apparatus charged to infringe the respective Lotters Patent in suit.

6. That such apparatus was manufactured and sold defendant as manufactured under the patents in suit by a manufacturer thereof, fully licensed under said patents by the owners thereof or those having rights to grant such licenses.

7. That the apparatus alleged to infringe said Letters Patent were manufactured and sold to defendant by a licensee of the owners of said patents in suit as aforesaid with the knowledge, consent and/or acquiescence of the owners of 164 said patent.

8. Upon information and belief, defendant denies that the alleged Letters Patent or either of them are good and valid in law, and on the contrary asserts that they and each of them are void and invalid,—

- (a) because of want of patentable invention,
- (b) because of anticipation by prior publications, and
- (c) because of prior knowledge and/or public use. 165

Defendant is not at present possessed of the particulars of the grounds of invalidity or particulars of the acts of invalidity, above specified, but begs leave to add the same hereto by proper amendment when such information and particulars are ascertained.

9. Defendant denies upon information and belief that the apparatus alleged to be an infringement embodies the alleged invention of said Letters Patent or either of them.

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*Defendant's Bill of Particulars
(Equity No. 50-178).*

WHEREFORE, this defendant denies that plaintiffs are entitled to the relief prayed for or to any relief, and hence prays to be dismissed with its costs in this cause sustained.

GENERAL TALKING PICTURES CORPORATION,
By DARBY & DARBY,
Attorneys.

167 Dated, New York, N. Y., August 7th, 1931.

Defendant's Bill of Particulars (Equity No.
50-178).

UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

168 WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,
Plaintiffs,
vs.

Equity
#50/178.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

Defendant, for its particulars of Paragraph 8 of its answer, as amended, says:

*Defendant's Bill of Particulars
(Equity No. 50-178).*

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1. The patents and publications which will be relied upon to establish invalidity of the patents in suit are as follows:

As to Arnold Patent No. 1,403,475:

Arnold	No. 1,114,845	granted Oct. 27, 1914
Arnold	" 1,118,176	" Nov. 24, 1914
Colpitts	" 1,137,384	" Apr. 27, 1915
DeForest	" 1,221,035	" Apr. 3, 1917
Langmuir	" 1,223,496	" Apr. 24, 1917
DeForest	" 1,348,157	" Aug. 3, 1920
Armstrong	" 1,113,149	" Oct. 6, 1914
Marconi	" 792,528	" June 13, 1905
DeForest	" 1,377,405	" May 10, 1921
Langmuir	" 1,273,626	" July 23, 1918
Marconi	" 627,650	" June 27, 1899
Marconi	" 647,007	" Apr. 10, 1900
Alexanderson	" 1,173,079	" Feb. 22, 1916
Kendall	" 1,216,136	" Feb. 13, 1917
Nichols	" 1,257,381	" Feb. 26, 1918

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2. The publications on which defendant will rely to establish the defense of want of patentable invention, in addition to the patents above enumerated, are:

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Pierce	No. 1,127,371	granted Feb. 2, 1915
Richards	" 1,103,688	" July 14, 1914
Langmuir	" 1,282,439	" Oct. 22, 1918

3. The documentary evidence upon which defendant will rely in support of its defense that the patentee was not the original and first inventor but, on the contrary, if the invention is

*Defendant's Bill of Particulars
(Equity No. 50-178).*

patentable at all, it was invented first by Irving Langmuir of the General Electric Company of and at Schenectady, New York, is Langmuir Exhibit No. 9, Pages of Langmuir Note-Book No. 458, as reproduced in the record of the United States District Court for the District of Delaware, Equity No. 549, The United States of America and Alexander Meissner, Plaintiffs, vs. DeForest Radio Telephone and Telegraph Company, *et al.*, Defendant's Exhibit Book, Volume 2, pages 442-493, inclusive.

As to Arnold Patent No. 1,465,332.

1. The patents and publications which will be relied upon to establish invalidity of the patent are as follows:

Yander Bijl	No. 1,350,752	granted Aug. 24, 1920
Colpitts	" 1,137,384	" Apr. 27, 1915
DeForest	" 1,201,272	" Oct. 17, 1916
Alexanderson	" 1,340,101	" May 11, 1920
Meissner	" 1,170,552	" Feb. 8, 1916
White	" 1,195,632	" Aug. 22, 1916
Kendall	" 1,216,136	" Feb. 13, 1917
Logwood	" 1,218,195	" Mar. 6, 1917
Arnold	" 1,129,942	" Mar. 2, 1915
Langmuir	" 1,273,626	" July 23, 1918

2. The publications on which defendant will rely to establish the defense of want of patentable invention, in addition to the patents above enumerated, are:

Defendant's Bill of Particulars
(Equity No. 50-178).

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Schloemilch,
 et al. No. 1,087,892 granted Feb. 17, 1914
 Nicolson " 1,255,211 " Feb. 5, 1918
 Alexanderson " 1,419,797 " June 13, 1922
 French Patent
 of Addition " 13,726/11
 British Patent " 13,248/14

3. The documentary evidence upon which the defendant will rely in support of its defense that the patentee was not the original and first inventor are the following patents:

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White No. 1,617,974 granted Feb. 15, 1927
 Kendall " 1,514,705 " Nov. 11, 1924

GENERAL TALKING PICTURES CORPORATION,
 By DARBY & DARBY,
 Attorneys for Defendant.

Dated: New York, N. Y.,
 November 13, 1933.

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SAMUEL E. DARBY, JR.,
 Counsel for Defendant.

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**Stipulation and Order Amending Answer
(Equity No. 50-178).**

UNITED STATES DISTRICT COURT,

SOUTHERN DISTRICT OF NEW YORK.

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WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

Equity No.
50-178.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

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It is hereby stipulated that the answer in this cause be amended by the cancellation of subparagraphs (a), (b) and (c) to Paragraph 8, thereof, and the substitution therefor of the following:

- (a) because the alleged invention of said patents was described in printed publications of the United States and countries foreign to the United States before the alleged invention of said patents or more than two years prior thereto,
- (b) because the said patents disclosed no patentable invention or inventions as distinguished from mechanical skill and natural progress of the art in view of the state of the art at the time the alleged inventions were made,

Stipulation and Order Amending Answer 181
(Equity No. 50-178).

(c) because the said patentees were not the original and first inventors of the alleged inventions of said patents,
(d) because the claims of the patents in suit are directed to inventions different from the alleged inventions at the time the applications for said patents were filed and that said claims were first made more than two years subsequent to publication of the said inventions, and 182
(e) because of double patenting.

HENRY R. ASHTON,
Counsel for Plaintiffs.

New York, N. Y., November 14, 1933.

DARBY & DARBY,
Counsel for Defendant.

New York, N. Y., November 13, 1933.

It is so ordered.

183

JNO. C. KNOX,
U. S. D. J.

Dated: 11/16/33

184 **Narrative Statement of the Evidence.**

**UNITED STATES DISTRICT COURT,
SOUTHERN DISTRICT OF NEW YORK.**

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

185 **GENERAL TALKING PICTURES CORPORATION,**
Defendant.

In Equity
No. 50-175.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

186 **GENERAL TALKING PICTURES CORPORATION,**
Defendant.

In Equity
No. 50-177.

WESTERN ELECTRIC COMPANY, INCORPORATED, ELECTRICAL RESEARCH PRODUCTS, INC., and AMERICAN TELEPHONE AND TELEGRAPH COMPANY,

Plaintiffs,

vs.

GENERAL TALKING PICTURES CORPORATION,
Defendant.

In Equity
No. 50-178.

Before:

HON. MORTIMER W. BYERS,
District Judge.

New York, February 7, 1934;
10:30 o'clock a. m.

APPEARANCES:

CHARLES NEAVE, Esq., Solicitor for Plaintiffs;
Charles Neave, Esq., Henry R. Ashton, Esq.,
H. A. Pattison, Esq., and E. J. Driscoll,
Esq., of Counsel.

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DARBY & DARBY, ESQRS., Solicitors for Defendant;
Samuel E. Darby, Jr., Esq., and
Ephraim Berliner, Esq., of Counsel.

PRIMA FACIE PROOFS.

Mr. Ashton: I will read paragraphs 1, 2 and 3
of the stipulation of counsel:

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"1. That the above entitled three suits may be
tried together as one suit.

"2. That plaintiff, American Telephone and
Telegraph Company, is the owner of the legal
title to the patents in suit; and that plaintiffs,
Western Electric Company and Electrical Re-
search Products, Inc., are licensees under the
patents in suit in the sound picture field and are
proper parties plaintiff.

"3. That, if otherwise admissible, printed or
photostatic copies of United States and foreign

191 patents may be introduced in evidence at the trial in lieu of the originals or certified copies thereof with the same force and effect as the originals duly proved, and the dates appearing thereon shall be accepted as correct, subject to correction should error appear; and, if otherwise admissible, photostatic copies of printed publications may be introduced in evidence at the trial in lieu of originals thereof, with the same force and effect as originals thereof duly proved; and the dates of publication appearing thereon shall be accepted as correct, subject to correction should error appear."

I offer in evidence copies of the eight patents in suit, and state that the claims relied upon as to each of the patents are as set forth in the diagram attached in the binder of patents.

*Claims Relied Upon As
To Each Part of De-
fendant's Apparatus.*

	Patent No.	
	Ex. 1-A, 1,231,764	1, 2, 4, 5, 6 and 7 as to A-41, A-36 and PA-39
192	Ex. 1-B, 1,426,754	8 as to A-41
	Ex. 1-C, 1,329,283	7, 10 and 13 as to PA-39
	Ex. 1-D, 1,349,252	15 as to A-41, A-36 and PA-39
	Ex. 1-E, 1,403,475	8, 9 and 10 as to A-41
	Ex. 1-F, 1,448,550	1 and 12 as to A-41
	Ex. 1-G, 1,465,332	3, 8, 10 and 11 as to A-41, and 1, 3, 5, 10 and 11 as to A-36 and P-32 Power Pack
	Ex. 1-H, 1,520,994	1 and 4 as to A-41.

(Marked Plaintiffs' Exhibits No. 1-A, 1-B, 1-C, 1-D, 1-E, 1-F, 1-G and 1-H.)

"4. That within six years prior to filing of the bills of complaint herein and subsequent to the issue of each of the patents in suit, defendant leased to motion picture theatre owners in the United States and installed in such theatre owners' motion picture theatres vacuum tube amplifiers as parts of defendant's talking motion picture reproducing apparatuses or systems, said amplifiers being identified as Types A-41, and 25-A comprising Types A-36 and P-32 Power Pack, and PA-39, which amplifiers were manufactured by The American Transformer Company of Newark, New Jersey, and sold by the latter to the defendant. The circuit and apparatus of each of the said types of amplifiers are correctly illustrated in the diagrammatic drawing annexed hereto."

194

I offer the drawing referred to in the stipulation, as Plaintiffs' Exhibit No. 2.

(Marked Plaintiffs' Exhibit No. 2.)

195

FRANK N. WATERMAN, called as a witness on behalf of the Plaintiffs, being first duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

Q. Will you state your residence? A. Summit, New Jersey.

Q. And your qualifications to testify in this case?

Mr. Darby: I concede Mr. Waterman's qualifications.

196 Frank N. Waterman—For Plaintiffs—Direct.

Q. Will you briefly describe what is involved in a talking motion picture recording system, with particular reference to this diagram of the Western Electric recording system?

Mr. Ashton: I ask that the diagram be marked in evidence Plaintiffs' Exhibit No. 3.

(Marked Plaintiffs' Exhibit No. 3.)

197

A. Outlining very briefly the apparatus involved in recording of motion pictures by reference to Exhibit No. 3, I note that at the left of the diagram there is indicated diagrammatically the camera and the microphones by which the picture was photographed and the sound pick-up, as the expression is. Since it is often not practicable to locate a microphone out of sight of the camera and in such a position that it adequately picks up all of the sound intended, it is not unusual to employ a plurality, two being common, located outside of the angle of view of the camera in positions favoring adequate picking up of the sound.

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The Court: When you use the term "picking up," do you mean in effect photographing the sound?

The Witness: No, I mean that the microphone diaphragm is exposed to the sound vibrations, that is, the pressure waves in the air, and is thereby set in motion to produce local currents. It is technical vernacular and merely means that by the microphone, so to speak, the sound, is reproduced. The currents which are pro-

duced in the microphones are exceedingly feeble, so feeble that to undertake to transmit them even in the most carefully shielded conducting systems to the rest of the apparatus would involve risk of the picking up of extraneous noises due to magnetic and electric fields resulting from electrical apparatus, such as the lights employed, that fill the space in the neighborhood. It is, therefore, customary to incorporate in the mounting of the microphone itself and carefully shielded from such extraneous electric and magnetic fields, an amplifier whose function it is to first take the extremely feeble signal and enlarge it to a point where it is large as compared to such disturbances as might get into the circuit due to the passage of the wires from the microphone to the other apparatus.

200

Sound thus picked up and amplified in the form of electric current is passed on to the mixer in the monitoring room shown just at the right of the studio stage in this diagram. This mixing device is under the control of a monitor. It consists of apparatus of the general nature of the gain control apparatus which we shall consider in one of the patents in suit, and the monitor mixes the product of the two microphones in such manner—that is, each component to such an extent—as to produce a true rendering of what is going on on the stage.

201

From the monitoring room the current goes to the amplifier room, where it is enormously amplified, and is then passed on to the recording room. In the recording room it is commonly

202 *Frank N. Waterman—For Plaintiffs—Direct.*

amplified again, although such amplifiers are not shown in this drawing, and then passes to the recording machines. Ordinarily there are two of these, one recording on disc and the other recording on film. Even though the final product is intended to be a record on film, the record is commonly made on a disc, because it affords a means of immediately approving or disapproving the quality of the record that has been made.

203 In order that the monitor may be guided in a proper mixing and in a proper control of the amount of signal passed on to the recording room, he is provided with a monitoring horn which is shown in the monitoring room. This may take its current either directly from the amplifying room or it may take it from the recording room. It is extremely desirable to be able to know in film recording just what it is that is going on the film. The recording, of course, is done on the film by a variable light. In this particular apparatus indicated here this is accomplished by a light gate which, opening or closing to a greater or less extent, varies the intensity of the illumination striking the film in an exceedingly narrow line.

204 The film is translucent. Consequently, it is possible to place under it a photoelectric cell to be influenced by the light passing through the film, and thereby to recreate an electric current which can be amplified and sent back to the monitoring room. Thus the monitor has the option of hearing the mixing which he has accomplished coming back directly from the amplifier room or he may hear it as it finally reaches the film, made by the very light which records the signals.

The recording on the disc recorder is done by means of a mechanical printing tool operated electrically by current from the amplifiers, and in case it is to be played back for a visa of the recording it is done by a stylus, very much as in the case of the ordinary phonograph. It is necessary that the recording camera and the recording film machine, the sound recording film machine, be operated in synchronism. The picture is taken on one film, the sound is recorded on another film or on a disc. The same problem of synchronism arises in film recording as in disc recording. It is therefore necessary that the camera and the film recorder as well as the disc recorder should be operated synchronously.

206

The mechanism for doing this is only indicated diagrammatically by a dotted line leading from the synchronizing mechanism on the camera through to the synchronizing machine in the power room and thence on to the synchronizing apparatus on the film recorder and on the disc recorder. These are rather complex apparatus and we are not concerned with their detail, but by means of this apparatus the synchronism of the three machines is preserved so that they run together with such exactness that when they are later reproduced the sound and the action go together.

207

Q. Will you now describe briefly the Western Electric reproducing system, for the purpose of illustrating what is involved in the reproduction of talking motion pictures?

Mr. Ashton: I ask that the diagram be received in evidence as Plaintiffs' Exhibit No. 4.

(Marked Plaintiffs' Exhibit No. 4.)

A. In the reproducing system the signals which have been recorded after enormous amplification upon discs or film are passed through the projecting machines, again converted into current, again enormously amplified and reconverted into sound in the horn back of the motion picture screen. This amplification many times means the passing of the current carrying the signal through a vast amount of apparatus, each amplifying tube having its own associated apparatus. If the signal is to be picked up from the disc or from the film, again converted into current and again amplified many times,—the power amplification involved here is in the order of hundreds of millions of times—and have any close resemblance to the original sound, the amplification must be of extreme accuracy. In the picking up of the sound from the record, be it disc or film, the disc-carrying turntable and the film operating apparatus is directly associated with the sound projector. If the disc is used, the two machines, the picture projector and disc, are driven synchronously by a common driving mechanism. If reproduction is to be from film, the separate sound film which was originally produced is printed onto the same film which carries the picture, and the film passes from the film supply reel shown at the top of the diagrammatic illustration of the projector in Exhibit No. 4, down through the picture projector, where the picture only is projected. It then passes down through the sound head where the film passes in front of a suitable light beam formed by an optical system imaging on the film the image of a slit interposed be-

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tween the light so that the light falls on the film in an extremely narrow line.

After going through the film the light which is varied in intensity by the variable intensity of the film record is received by what is known as a photoelectric cell. This is a device which depends upon the property of certain substances, particularly the alkali metals, of giving off electrons when light impinges on them. These electrons pass across the space within the bulb and are received on an anode device and constitute an electric current. This electric current is amplified and passed on to the main amplifying system.

212

Q. Does it have to be amplified immediately?

A. Yes.

Q. Why is that? A. For the same reason. Because of its extremely feeble character. It is even more feeble than that generated by the microphone. It must be amplified to such strength of current at the time that incidental pick-ups of extraneous noises coming from electric light wires and the like will not introduce disturbances. Since a reel of film holds only a limited amount of film, it is common in a projecting room to have two projectors, the second reel being set up ready to go when the first runs out.

213

Q. Will you now describe briefly, for the purpose of the record, the three-electrode vacuum tube, with reference to this diagram which I ask be marked in evidence as Plaintiffs' Exhibit No. 5.

(Marked Plaintiffs' Exhibit No. 5.)

214 *Frank N. Waterman—For Plaintiffs—Direct.*

A. The three-element vacuum tube, variously known as the audion, electron tube, thermionic tube or just an amplifier tube, consists, in essence, of a small incandescent lamp bulb containing a filament, particularly selected for its capacity to give off electrons when heated.

215 It also contains an anode element or plate, marked P in Exhibit 5, which acts as the other terminus of a circuit connected to the tube and marked output. Between these two elements, there is located a grid-like structure ordinarily composed of fine fibres, suitably stretched in grid form, which acts as the control element in the tube, and between which, and the filament or cathode, the input circuit carrying signals to be amplified, are introduced.

I have referred to amplification. The tube has a number of other functions, and is not structurally different, so far as its description goes, for other functions.

216 The space within the container is exhausted to a very high degree of exhaustion, so that the operation shall not be essentially affected by the presence of gas. Air, of course, being gas. Between the cathode and anode, the filament and plate, there is connected a polarizing battery marked B, and for the purpose of heating the filament, there is a battery marked A. That is common in the art to refer to these two batteries as the B battery and the A battery.

By the Court:

Q. The B battery is connected to what? A. The B battery is connected with its positive terminal to the plate and its negative terminal to the filament.

This wire runs from the negative terminal of the B battery to the negative terminal of the A battery, which is itself directly connected to one leg of the filament circuit.

Q. The negative terminal—A. Is marked with the minus sign.

Q. That is connected directly to the filament, is it? A. That is connected directly to the filament, passing through the negative terminal of the A battery on the way.

By Mr. Ashton:

Q. Now, will you say how the vacuum tube operates as an amplifier? A. The heating of the filament causes, by a species of evaporation, the emission of what are known as electrons. There is a great deal of controversy as to what they are, but for our purpose, however, we can consider them merely as particles of negative electricity behaving like small projectiles. They are emitted from the filament with various velocities, sufficient to carry them along only a short distance away from the filament, but in the absence of any other elements, they would exist in the nature of a cloud in the immediate vicinity of the filament. When a positive potential is applied to the plate, there is created within the space and between the plate and the filament what is known as the electrostatic field. The word "field" in that sense, means merely space. When we say electrostatic field, we mean that the space intervening between the terminal, is in some sort of state of stress, that can be demonstrated physically by the use of light powders that will arrange themselves in lines, very much

220 *Frank N. Waterman—For Plaintiffs—Direct.*

as iron filings will arrange themselves in lines in the magnetic field. These lines of force in the electrostatic field afford the means of transit for the electrons to the plate, using perhaps a crude figure, that is in substance what happens.

By the Court:

221 Q. Transit between what? A. Between the filament and the plate. So that when the plate is made positive, the electrons will pass across from the filament to the plate and they will pass in ever increasing numbers up to the point where the field which they themselves create, since they are negative charges, is such as to restrict any further emission from the filament.

222 The effect of the grid is to modify the electrostatic field. When the grid is positive, for example, due to one-half of an alternating signal wave coming in, it aids the field due to the plate and the number of electrons which pass across is increased, which means that the current in the output circuit increases. When the negative half of the signal wave is imparted to the grid, so that the grid is made more negative, then there is a decrease of the electrons. The grid acts to restrain the electron flow, and the current in the output circuit suffers a decrease. In the absence of a signal, therefore, a certain steady current flows from the battery B to the plate, thence through the filament back to the battery.

I call your Honor's attention to the fact that I have traced that flow of current in the opposite direction to the movement of electrons. That is due to an unfortunate confusion which

exists in the art, because in the earlier days, the assumption was made that the direction of current flow was from the positive to the negative pole. It is quite probable, in view of present-day knowledge that what really happens is that electrons which are negative charges, flow in the reverse direction, but nevertheless the terminology originally employed is still used, so that the procession or swarm of electrons going across from filament to plate is spoken of as the current flow from plate to filament.

224

In the absence of the potential applied to the grid, a given plate battery and a given tube will supply a given current, which current will be constant, but in view of the fact of the grid which I have just been describing it will be clear, I hope, that this otherwise constant current is continually varied, receiving a flow in response to the charges impressed on the grid. Thus there is, in effect, an alternating current more or less corresponding to the current in the input or the voltage in the input circuit impressed on or superposed on the normal direct current in the plate circuit of the tube.

225

The tube in this capacity is found to act as an amplifier. This may be shown in a simple way, for example, by simply increasing the battery B, say by one volt. If we had a measuring instrument in the tube circuit we would find that the current grows.

If we then applied to the grid a negative voltage until we restored the current to its original value, we would find that the voltage that was necessary to apply to the grid in order to make the same change of output current that was caused by one volt increase in the plate bat-

226 *Frank N. Waterman—For Plaintiffs—Direct.*

ter, we would require less voltage applied to the grid, and that ratio is known as the amplifying factor, or for short, the mu of the tube, the ratio of the plate voltage increase required to produce a small increase of plate current and the change of grid voltage, that would be required to annul it.

227 It follows that when a signal is applied to the grid, a signal alternating current occurs in the output circuit the voltage of which is larger than the voltage of the signal applied to the grid. I have not defined the term "voltage" and the term "current." A current flows in response to a pressure. That pressure may be created by the chemical action of the battery, or by the rotation of a mechanical generator, or in other ways; but the unit in which it is measured is called the volt, and we quite commonly substitute the word "voltage" for pressure. But there is a wealth of terminology governing that same thing. It is often called electromotive force; it is called difference of potential or, for short, simply potential—all of those terms meaning so far as we are concerned the same thing. We speak of the voltage or the potential or the electromotive force of a battery, for example.

228 The current or actual transfer of electricity through the circuit is the quantity of electricity passing a given point per second. In other words, it is a rate of flow of the electricity and is measured in a unit called the ampere. Where we are dealing with small quantities we often refer to a milli-volt or a milli-ampere, meaning a thousandth of a volt. Oftentimes we speak of a micro-ampere, and there might be occasions to refer to micro-amperes, the current of some

tubes being small enough to be most conveniently measured in terms of microamperes, others in terms of milliamperes.

Q. What does "micro-ampere" mean? A. A millionth of an ampere. So when we have a signal voltage applied to the input circuit between the grid and filament it results in a superimposed alternating current in the tube circuit, the voltage of which is higher than that of the signal applied to the input circuit.

Perhaps I ought to make my definitions complete by saying that the need of a pressure in order to force the flow of the current arises from the existence in the circuit of what is broadly known as impedance. There is more than one kind of impedance, and we may find it necessary to speak of reactance resulting from the presence of an induction coil or condenser. There is in all conductors what is known as resistance, which is a property of the conductor itself and which restricts the flow of current. A pressure is required to overcome this resistance or to overcome an impedance and to cause a current to flow.

230

Q. Can we ordinarily here think of impedance as resistance to the flow of current? A. In nearly all cases I think that will arise in this case we can consider the terms "impedance" and "resistance" as synonymous. Specifically we can consider that is true in the case of the tube, since we are dealing wholly with audio-frequencies. I ought perhaps to define what I mean by that.

231

The voice acts to create alternate waves of pressure and rarefaction in the air, and one cycle comprises one compression and one rarefaction.

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Frank N. Waterman—For Plaintiffs—Direct.

In general a cycle extends from where any phenomenon starts in a given direction until it returns to the same direction. So a period of a sound wave extends from the beginning, say, of one condensation or compression of the air to the beginning of the next, and that would be variously referred to as the period or the cycle. We will speak of the number of such periods occurring in a second as the frequency.

All ordinary sound is a complex of frequencies.

233 The piano note, for example, as I remember it contains some forty-six, or at any rate between forty and fifty, overtones that are necessary to express the particular quality of tone that the piano emits.

Q. Will you now briefly describe the nature of sound waves with reference to these oscilograms of voice currents?

Mr. Ashton: I will ask that these oscilograms of voice currents be received in evidence as Plaintiffs' Exhibit No. 6.

(Marked Plaintiffs' Exhibit No. 6.)

234

A. It is possible to make a current write its own autograph, and that is done with an instrument known as an oscillograph. Exhibit No. 6 represents one continuous length of record which for convenience has been cut up into sections and pasted in order onto a sheet and photographed. The sentence which the oscillogram represents is given on the sheet just under the title, "Joe took father's shoe bench out." The strips have black scale marks, short vertical lines marked under them, the distance from one scale mark to the next being one one-hundredth of a second. Each tenth mark is indicated by the num-

erals 1, 2, 3, 4, et cetera. You will notice that in general the consonants occupy very short intervals of time.

Take the time interval from the beginning of "J" which is just about the beginning of the first vertical line, to the beginning of "o." It is only two one-hundredths of a second, whereas the "o" sound extends down to near the middle of the next line, there being a short pause between the end of the first sound and the beginning of the "t" sound. I call attention to the fact that the consonant sounds in general are composed of extremely high frequencies. This is indicated by the very many wavelets found just following the letter "J," between it and the letter "o." The current alternated, in other words, with very great rapidity.

236

That is not a single frequency there shown but a composite of many frequencies, in order that the characteristic sound of "J" may appear. Those must be rendered faithfully with respect to all of the essential component frequencies, and the component frequencies must be present in their proper proportioned intensity. One harmonic, for example, may be quite strong, comparable almost with the fundamental; others may be quite feeble. But all are necessary, and it is necessary that the relative intensities should be preserved. If the oscillogram were on a very much larger scale those things would appear more readily.

237

The vowel sounds are very complex, but their fundamental frequencies are of a much lower order. That is very well illustrated by the letter "o." That very irregular line is in reality composed of a large number of smooth sinusoidal

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Frank N. Waterman—For Plaintiffs—Direct.

waves superimposed upon one another in their correct intensity relation and in their correct phase relation. For example, if a given wiggle is to be composed of a fundamental and a second harmonic, the wave will be of quite different shape if it so happens that the second harmonic starts so that one of its peaks agrees with the peak in the fundamental, or whether it does not, whether it is timed in some other relation.

239 So those various things are taken account of in the formation of the shape of this signal wave, that is indicated. It is interesting to note how extraordinarily complex the sound "th" or the sound that intervenes, the finishing of the "a" leading into the "th" in "father." It gets increasingly complex. Then the "sh" sound in "shoe" is extraordinarily complex. It extends from just to the right of the time interval marked 7 and something over two divisions to the right of the time interval marked 8. Very high frequencies are there illustrated in very complex combinations.

240 Your Honor has doubtless noted in the early radio sets how very very badly the "sh" sounds were often reproduced, because of the inability of the amplifiers to reproduce such a great complexity of sound waves.

Q. Will you now briefly describe and point out the range of frequencies to be reproduced in talking motion pictures, public address systems, et cetera, with reference to this diagram from the magazine "Electronics"?

Mr. Ashton: I will ask that that magazine, "Electronics" be received in evidence as Plaintiffs' Exhibit No. 7.

(Marked Plaintiffs' Exhibit No. 7.)

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A. This sheet illustrates the frequencies in the entire useful range; but we are concerned only with that part marked "Audible spectrum" in the lower left hand portion. The limits or human ear sensitivity are there given as from 16 cycles per second to 16,000 cycles per second. Of course, ears differ, and any particular individual might not be able to hear such an extreme range, some might even surpass it; but the 16 to 16,000 is taken as the limits of human sensitivity.

242

The Court: The normal?

The Witness: Yes, the normal limits. The range of the piano is indicated by the keyboard shown at the bottom of the figure, and the various instruments of the band and orchestra are noted by brackets above.

Mr. Ashton: I call your Honor's attention to the statement of the Court of Appeals in the Wallerstein case, beginning at page 2 of the opinion:

"The problem of amplification was to reproduce without distortion the input of the amplifier and its output greatly increased in energy. Speech has been found to be extremely complicated, each of the ordinary sounds being composed of many frequencies which must be accurately reproduced. The range of audible frequencies is from 16 to 16,000 vibrations per second. For sound pictures and public address systems substantially from 30 to 5,000 cycles must be reproduced without distortion in order to give the high quality which is known today. Greater

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power is needed to drive the loudspeakers of these systems than is required for radio or telephone. The lack of faithful reproduction would be so accentuated under certain conditions as to destroy the utility of the systems. The success of sound pictures was due solely to high quality reproduction—that is, without distortion.”

245 Q. Now, will you briefly summarize as to each feature of audio amplifiers to which the patents in suit relate? A. The Lowenstein patent, known as the Negative Grid Bias Patent, goes to the organization of the tube and its input circuit, the electrical circumstance of the grid of the tube being such as to avoid distortions due to the flow of current in the input circuit. The Mathes patent, the Resistance Bias Patent, shows a convenient way of obtaining the grid bias by means of a resistance. Insofar as Claim 8 in suit is concerned, it goes to the location of the resistance in the path of the current which heats the filament.

246 If you will refer more particularly to Fig. 1, your Honor, the resistance which produces the bias on the grid is shown in Fig. 1 at 9. It is in the circuit of the filament heating current which flows from battery 6, starting at the right hand end of the battery 6 marked plus. The current flows through the filament 3, then through the resistance 9, then through the resistance 15, then through what is known as a choke coil 14, then back to the battery.

Mr. Ashton: I might say, your Honor, that Mr. Waterman in this answer was

going to state briefly the inventions, what they are directed to, and that a little later he is going to discuss each one in detail and actually trace the circuit. I want to call your attention to the fact that he is going to trace through these circuits in detail in answer to specific questions about each patent.

The Witness: The Mathes patent has the advantage that if the battery system of the tube fluctuates, as for example, by charging as illustrated in Fig. 1 of the drawings, the bias is made to vary as the grid current varies, for reasons that I will later explain.

The Arnold Patent 1,329,283, known as the Power Circuit Patent, sets forth a number of discoveries made by Arnold as to the fundamental properties of tubes, and insofar as the claims in issue are concerned is directed to the obtaining of a large power output by an efficient relation between the tube and the circuit into which it is working, while at the same time getting a high degree of fidelity in the result. It is concerned, therefore, with the load device characteristics applied in the output circuit and the internal tube characteristics connected to that output circuit in their relation to one another.

Patent 1,349,252, known as the Straight Line Characteristic Patent, deals with the obtaining of essentially a true reproduction in the output circuit of the voltage actually applied to the grid in the input circuit; whereas the Lowenstein patent, for example, has particularly to do with

250 Frank N. Waterman—For Plaintiffs—Direct.

avoiding distortion arising in the input circuit largely exterior to the tube; this patent has to do with the arrangement of the external output circuits, to avoid difficulties arising purely within the tube. In other words, briefly the tube is not naturally a faithful repeater. Their problem was to make it repeat faithfully. That is the problem that is dealt with in Patent 1,349,252.

Patent No. 1,403,475 has to do with a situation where a multiple stage amplifier is used.

251 The signal is amplified in one tube and passed on to the second tube. The problem is how to connect the tubes together so that the input of one connects with the output of the other.

By the Court:

Q. Unimpaired? A. Unimpaired, yes. There are various ways of doing that. This patent proposes what is known as the resistance capacity coupling method. More accurately, we should call it the resistance coupling capacity connected, but the phrase is "resistance capacity coupling" and it gives a mode of coupling or associating two tubes, which treats all frequencies alike within a very wide range. All frequencies involved in the sound spectrum, for example, come through substantially equally well with it, without any distortion in the coupling means.

Patent No. 1,448,550 is known as the "definite input impedance" patent. When the line conveying the incoming signal looks at the tube,—to use the common method of expression,—what it sees would depend upon how the tube is being operated, and what happens in the line will be in a measure affected by what the line sees in

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looking into the tube. Also the tube has other properties than those which we have heretofore considered, and those which enter into its function as an audio frequency amplifier. It acts in a measure like a small condenser, a condenser being two insulated conductors in which there is capacity between them, in two insulated conductors separated one from the other by a sort of dielectric in which an electrostatic field can be set up.

The tube connected across the input circuit has a certain effect in view of this capacity. They will not necessarily be alike with two different tubes. There is a class of problems, therefore, that arises both in telephone cable work and in public address systems and in talking motion picture amplifiers that grow out of the fact of what the incoming signal line sees when it looks at the tube. To make the input circuit of the tube a constant thing, regardless of change of tubes and to eliminate the factors which may arise out of the capacity of the tube, Arnold puts across the input circuit a resistance selected from the point of view of what the engineer wants to have the line see. It is indicated simply as resistance 6 in the figure.

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Patent No. 1,465,332 is the "common battery filter patent" and illustrates the connection and supply of two tubes to and by a single battery. The plate circuit of each tube has to be supplied with a source of voltage and current, which is indicated at 20 in the drawing, and in order that the very much enlarged signal coming out of the said tube may not react back into the first by means of a common connection to the battery, Arnold has organized the particular circuit

256 *Frank N. Waterman—For Plaintiffs—Direct.*

there shown that I will later deal with in detail. The problem there was to supply from a single source two or more tubes and with preserving the alternating current separateness while giving them a direct current unit.

Patent No. 1,520,994 goes to the question of the overall gain control of the amplifier. The small signal comes in at one end of the amplifier and the large one—relatively large one goes out at the other end. In order to control to a desirable volume that which goes out from the final output stage, it is desired that some means shall be provided which shall not disturb any of the operating characteristics of the entire apparatus which has to do with fidelity, that is accuracy of reproduction of the signal. This patent is concerned with accomplishing that result in a way that shall not have any deleterious effect on the action of any element or tube or circuit element in the amplifier. Briefly it is done by means of a potentiometer voltage driving off the voltage plate to the grid of the second tube.

258 The potentiometer resistance is connected across the secondary, 24, of the intermediate transformer, and the variable quantity of the voltage extended in that resistance is applied to the grid, the grid is negatively biased and therefore its control has no effect whatever on the circuits, to disturb their performance.

By Mr. Ashton:

Q. Are these inventions which you have referred to, capable of use in a single amplifier?

A. Yes, they commonly are so combined.

Q. Will you now describe very briefly the defendant's circuits with reference to the diagram

Plaintiffs' Exhibit 2? A. Plaintiffs' Exhibit 2 is a purely schematic illustration of the component parts of the defendant's amplifier. The amplifier is built in three units, the parts included in them being indicated by dot-dash lines on the drawing. There is a preliminary or photo-electric cell amplifier A-41; next there is a fader element which is separate and used where there are two projectors, as I have already described.

I think I did not quite finish the answer I was on before lunch. I may say, because of the shortness of the roll of film, it is customary to employ two machines in the projection room, and as these are loaded with film, which overlap, that is to say, the film of the second reel will start before the other finishes.

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Mr. Ashton: Note that the witness is referring to Plaintiffs' Exhibit 4.

A. (Continuing.) The fader is used to transfer the signal from one to the other after they are started and synchronized, so as the fader handle is moved, the sound from one machine gradually dies out and the sound from the other machine begins, so that the audience is not conscious of a change of reel.

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The next amplifier in Exhibit 2 is that marked "intermediate amplifier" A-36. It contains only the audio frequency units and the power supply is from the dots indicated below and marked "power pack P-32."

By the Court:

Q. Does that take the place of the batteries?
A. That takes the place of the batteries which

262 *Frank N. Waterman—For Plaintiffs—Direct.*

are shown connected to the preliminary amplifier A-48. Much higher power and higher voltages are required for this amplifier, and it is convenient, where large power is required to be able to supply the power from an electric socket, and the power pack P-32 is the means for accomplishing that result. So far as we are concerned at the moment, it is the B battery and the A battery combined.

263 The last amplifier is marked power amplifier PA-39. So-called power tubes are employed in this amplifier and they deliver a very large amount of output power to the loudspeakers, one of which is the stage speaker and the other is the small monitor speaker, by which the monitor, controlling the performance of the amplifier, may tell whether or not he has it adjusted correctly for the proper volume and whether the amplifier is correctly performing in all its parts.

264 I neglected to refer to the input, which is at the left-hand and shown as a photo-electric cell. This photo-electric cell is mounted in what is called the sound head in each case of the Western Electric projector. The film passes through a suitable gate and the light shines through the gate, on to a sensitive surface of the photo-electric cell. The result is to cause electrons to be given off each unit of light, so as to cause a setting off of electrons, and this electron current must correspond precisely in its character to all the complex characteristics of the sound wave.

The electrons pass to the anode and are passed on through the system progressively amplified until a large power, taken at the final output

circuit, as compared to all but infinitesimal power going into the input of the first stage.

By Mr. Ashton:

Q. The A-41 amplifier at the left is mounted on the machine itself in defendant's arrangement, is it not? A. I so understand. I have not seen the actual projector. It is in the Western Electric. It is ordinarily necessarily so, because the amplification must begin immediately.

Q. Where are the intermediate amplifiers and the power amplifiers ordinarily located? A. In an amplifier room supplied for the purpose; sometimes in the projecting room, but not ordinarily there.

Q. On what type of supporting panels? A. They are ordinarily panels put in racks, very much like a radio set, on a very much enlarged scale.

Q. Will you point out as briefly as possible the location of the inventions in the different parts of defendant's amplifier circuit? A. Without going into detail, the Lowenstein invention is illustrated by each of the amplifier tubes in each of the amplifiers, there being means that I will later point out in detail in each tube for providing the negative bias to the grid.

The Mathes patent is illustrated in the A-41 amplifier, the resistances R-1 and R-2 being, as I will explain later in detail, the means employed for actually producing the bias.

The Arnold Patent 1,329,283 is illustrated in the amplifier PA-39, in other words, this power circuit pack is illustrated by the power amplifier of the defendant's apparatus.

268 Frank N. Waterman—For Plaintiffs—Direct.

The straight line characteristic patent 1,349,-252 is illustrated in the tube V-1 of the A-41 amplifier, the tubes V-3 and V-4 and V-5 of the A-36 amplifier, and the tubes V-6 and V-7 of the PA-39 amplifier.

Mr. Ashton: I call your Honor's attention again to the right-hand column of the diagram in the book of the patents, which actually lists the types of amplifiers as to each patent.

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The Witness: The resistance capacity coupling patent 1,403,475 is illustrated in the coupling means employed between the photo-electric cell and the tube V-1, where extremely minute currents from the photo-electric cell must be amplified with extreme faithfulness in all their characteristics, without any loss of distortion in the circuit, and this coupling is particularly useful for such extremely weak signals.

Patent 1,448,550, the definite input impedance patent is illustrated in the tube V-2, that is to say, the input circuit of the tube V-2 of the A-41 amplifier.

270 The common battery and filter patent 1,465,332 is illustrated in the A-41 amplifier, where both stages are supplied by common batteries A and B¹, filaments being supplied from the battery A to the plates from the battery B¹.

It is also illustrated in the A-36 amplifier where the power supply is from the power pack P-32, plate circuits of both of the tubes,—of three of the tubes,—there being three tubes in this amplifier, two in the last stage, under special arrangement which I will describe later, being supplied by the power pack P-32.

Frank N. Waterman—For Plaintiffs—Direct. 271

In the amplifier P-39 there is only one stage, although there are two tubes, they act as a single stage, and this patent therefore does not apply to the A-39 amplifier.

The gain control patent 1,520,994 is illustrated in the input circuit of the second stage, namely the tube V-2 in amplifier A-41, where the desired proportion of the incoming signal is selected and taken to the grid as I will more fully explain later.

Q. Now, will you state just generally some of the uses to which these inventions have been put, and in particular with reference to different fields of use? A. They have been extensively used in wire telephony and radio telephony; also in public address systems. They are of vital importance to electrical recording, whether on discs or on film, and they are equally essential in the reproduction of such records for the purpose of talking motion pictures. Of course, there are many other specific uses, particularly laboratory uses where they are important, but those are the major ones.

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Mr. Ashton: I would like to suggest, your Honor, if there is no objection, that Mr. Waterman's testimony be interrupted at this point for the purpose of putting on several fact witnesses, who will testify as to the use of these inventions in particular situations, starting with the trans-continental line in 1913.

Mr. Darby: I have no objection.
(Witness temporarily excused.)

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Burton W. Kendall—For Plaintiffs—Direct.

BURTON W. KENDALL, called as a witness on behalf of the plaintiffs, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

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My name is Burton Warren Kendall; I reside at 74 South Munn Avenue, East Orange, New Jersey. I am employed by the Bell Telephone Laboratories as toll systems engineer. I entered the employ of the Western Electric Company February 5, 1913, in the research branch of the engineering department.

Q. State very briefly what was your higher educational experience prior to your employment by the Western Electric Company? A. I was graduated from—

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Mr. Darby: Unless there is some particular reason,—I don't know whether this witness is being qualified as an expert—

Mr. Ashton: No, he is not.

Mr. Darby: I know who Dr. Kendall is, and I do not require any such qualifications.

Mr. Ashton: Very well, I will withdraw the question, if you wish.

By Mr. Ashton:

Dr. Arnold was one of the supervisors in the research branch when I was employed by the Western Electric Company. That is the branch which I entered. I was placed by Dr. Arnold on the work of repeater development.

Q. I show you a tracing number ES160,131, dated December 8th, 1914, entitled, "Vacuum Tube Repeater Transcontinental Circuit," which I ask be identified as Plaintiffs' Exhibit 8 for identification.

(Marked Plaintiffs' Exhibit No. 8 for identification.)

Mr. Ashton: Also tracing ES160,132, dated December 8th, 1914, and also entitled, "Vacuum Tube Repeater Transcontinental Circuit," which I ask to be marked for identification as Plaintiffs' Exhibit 9. 278

(Marked Plaintiffs' Exhibit No. 9 for identification.)

Mr. Darby: May I inquire the relevancy of this material?

The Court: It is not offered in evidence yet; it is only marked for identification.

Mr. Darby: I know, but the witness is being questioned about it.

Mr. Ashton: I will be very glad to state. The purpose of this part of Mr. Kendall's testimony is to show the use of some of these inventions in connection with the opening of the transcontinental line in January, 1915, and which we want to put on the record. 279

Mr. Darby: Very well. I haven't any objection to using it for that purpose, but to save you time, I am perfectly willing to stipulate that by September of 1915 every one of the inventions, at least by September, 1915,—every one of the inventions purporting to be covered by the

claims here in issue of each of the patent suits, was in commercial, successful public use, by at least 1915.

Mr. Ashton: We will run through it very briefly, your Honor. It won't take but a short time to cover those uses and for the purposes of the record, I think it should be stated by the witness.

The Court: Do you think Mr. Darby looks like a Greek bearing gifts?

Mr. Ashton: No, I don't think that, but under the circumstances, I think we should have it in the testimony.

The Court: As long as you are going to pay for the testimony, I don't see why you should not have it.

Mr. Darby: As I understand, Mr. Ashton, you are not introducing it for the purpose of carrying the date of the invention back, or anything like that?

Mr. Ashton: Not as to this part of the deposition.

Mr. Darby: Very well.

The Court: Is there any objection to receiving these in evidence now, Mr. Darby?

Mr. Darby: No, your Honor.

The Court: The reason I ask is because I do not wish to permit the witness to testify to the contents of an exhibit which is simply marked for identification. If there is no objection, why not have it marked now?

Mr. Darby: I have no objection, and I am perfectly willing to accept, without further proof, these papers as to their accuracy and authenticity, on the under-

standing, of course, that it is not being used for the purpose of carrying the date of the invention back.

Mr. Ashton: I offer the two drawings in evidence as Plaintiffs' Exhibits 8 and 9.

(Drawing ES160,131 marked Plaintiffs' Exhibit No. 8; drawing ES160,132 marked Plaintiffs' Exhibit No. 9.)

The Witness: No. 160,131 is the circuit of the right-hand of two boxes, which together, made up a two-way telephone repeater and No. 160,132 is the circuit of the other box, the left-hand box. These circuits were used in about December, 1914, in the making up of these repeaters for the transcontinental line and are circuits of the repeaters as used at the time it was opened. The line was opened in the latter part of January, 1915.

The Bell System has maintained commercial transcontinental service continuously since the opening of the transcontinental line in January, 1915, with the possible exception of line breaks, due to storms. As to whether I had anything to do with the opening of the transcontinental line in 1915, the organization was in my department, and was largely responsible for wiring up these repeaters, and I was at the time the transcontinental line was opened at Omaha and in charge of one of those repeater stations. Repeaters were provided at Pittsburgh, Chicago, Omaha, Denver, Salt Lake City, Winnemucca, Nevada.

These repeater stations are referred to in this article of the San Francisco Bulletin of January 15, 1915, in the second column, down near the

286 *Burton W. Kendall—For Plaintiffs—Direct.*

bottom it says there are five amplifying stations en route at which the voices are repeated, and so on.

(Offered and marked Plaintiffs' Exhibit No. 10.)

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Mr. Ashton: I also offer and ask that it be marked as part of the same exhibit 10, articles in the New York Times of January 26, 1915; San Francisco Chronicle, January 27, 1915, and the Morning Tribune of January 26, 1915.

Mr. Darby: May I ask the purpose of these documents, Mr. Ashton?

Mr. Ashton: They establish the time when the transcontinental line was opened in January, 1915.

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Mr. Darby: That is not disputed.

Mr. Ashton: And show that the stations were located at those various places.

Mr. Darby: What does that establish? You were not willing to accept my concession that these inventions were used, and you said you wanted to put your proof in, but I don't think this is proof of that at all.

The Court: This is only proof that newspapers said so, and the witness is telling us the fact.

Mr. Darby: It is apparently put in as atmosphere, to show what a wonderful thing this transcontinental telephone was. We will all agree that it is a marvelous thing—

The Court: Are you objecting, or just making a statement?

Burton W. Kendall—For Plaintiffs—Direct.

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Mr. Darby: Yes, sir, I am objecting, your Honor, because this is going to be a very heavy case and I want to keep the record down as much as possible.

The Court: One more exhibit won't make much difference, will it?

Mr. Darby: One exhibit will not, but this may be used as a precedent and may open the door to let many more in.

The Court: I will overrule the objection; you may have an exception.

290

(Marked as part of Plaintiffs' Exhibit No. 10.)

By Mr. Ashton:

Referring to the drawings Exhibits 8 and 9, the tube marked No. 1 on ES160,131, Exhibit 8, is a voltage amplifying tube used in the transcontinental repeater circuit. This tube is like the tube to which I have just referred as being used in the circuit of Plaintiffs' Exhibit 8.

291

Mr. Ashton: I offer the tube in evidence as Plaintiffs' Exhibit No. 11.

(Marked Plaintiffs' Exhibit No. 11.)

The type of tube used in the second stage of the transcontinental repeater was a tube built to deliver a larger current. We call it M type tube. The internal construction of this tube is that of the type M tube.

Mr. Ashton: I offer the tube last referred to by the witness in evidence, as Plaintiffs' Exhibit 12.

(Marked Plaintiffs' Exhibit No. 12.)

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Burton W. Kendall—For Plaintiffs—Direct.

By Mr. Ashton:

The internal impedance of the M tube and that of the circuit to which it went were equal or as nearly as we could make them so. The alternating current portion of the output current varied linearly with the alternating input voltage. As to the values of the resistance of the input circuits of each of the tubes in the transcontinental circuits, the tube marked No. 1 on drawing No. 160,131 had its input circuit, that is grid to filament connected across a resistance of about 500 ohms. The tube marked No. 2 had its input circuit connected across a portion of the resistance of 600,000 ohms total, and the connection in the second one is adjustable.

293

A negative grid bias was used on each of the tubes. In earlier work we made experimental tests of a single tube repeater circuit with a positive bias on the grid and without a gain control in the input circuit. From early in the Fall of 1913 through to the latter part of February or early in March, 1914.

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As to the circumstances under which we changed from using a positive bias to using a negative bias, and from not using a gain control to using a gain control, we had worked for some months without great success with a positive bias and with gain control not provided through a potentiometer arrangement in the input circuit, and early in March, 1914, discussing the matter with Dr. Arnold he suggested to me that we change the polarity of the C battery which we were using—the C battery being the battery applied between the filament and grid—and from positive on the grid to place the negative side of the battery on

the grid. He further suggested at the same time that another trouble that we had regarding the input impedance of the tube would be met under those conditions by stretching across the high side of the transformer a resistance equal to that resistance into which the transformer was built to work; and, further, that the matter of adjustment of the gain of the amplification—that is, given by the tube—could then readily be attained by making the grid contact adjustable along the potentiometer so as to take off a larger proportion of the voltage across that resistance. That was the beginning of March, 1914. Before Dr. Arnold made these suggestions to me, we had been using other methods to adjust the amplification of the repeater. At one time we were adjusting the amplification by varying the number of cells in the plate battery. Later we kept the number of cells in the plate battery fixed, but put in a series resistance and a shunt resistance, adjustable in the circuit, beyond the output transformer.

296

This notebook marked No. 25, B. W. Kendall is a notebook which was kept by me. On page 68 there is the note "Pgh," which was brief for Pittsburgh, one of the stations where we were experimenting; dated "3/10/14," and the statement which I might as well quote is: "Arrived, to put in St'd B audions, with higher B current, —cells"—or negative cells—"in C ckt, high fixt resistance across high side of input tr."—transformer—"adjusting gain by tapping off across part of this for the grid."

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Mr. Ashton: I offer page 88 of the witness' notebook in evidence as Plaintiffs'

298 *Burton W. Kendall—For Plaintiffs—Direct.*

Exhibit No. 13, and ask that a copy be substituted.

(Marked Plaintiffs' Exhibit No. 13.)

This notebook No. 42 is one that was kept in Philadelphia, the entries being largely by one of the men in my organization who was stationed there observing the operation of the repeaters. The writing is in a great many cases of someone other than myself. It is carbon copies of reports which he sent in to me. This notebook was kept under my direction. Frequently my writing is in there, when I happened to be in Philadelphia; but most of the writing is Mr. Thompson's.

299

Mr. Darby: No objection.

300

The Witness: This record under date "March 23, 1914, Monday," states that No. 9, which refers, I believe, to the New York-Baltimore circuit numbered 9—was on the audion circuit, and further states, "This is the first day of service of new audion and modified audion circuit." The circuit shown below shows these features which I have mentioned, that Dr. Arnold told me about a few days before. That is, the input transformer closed through a resistance. A portion of the voltage across this resistance tapped off by a movable contact to apply to the grid, and between this tapping off and the grid a battery poled with a negative toward the grid. I saw the circuits, including this gain control, in service in Pittsburgh experimentally on the 10th or 11th of March, and at Philadelphia on the 23rd of March, 1914.

Mr. Ashton: I offer the page of the notebook, No. 42, which has been referred

to by the witness, in evidence as Plaintiffs' Exhibit No. 14, and ask that a copy be substituted.

(Marked Plaintiffs' Exhibit No. 14.)

The modifications which I have referred to, including a negative bias on the grid and a gain control in the input circuit, became a standard on repeater circuits. They were widely used after this time on repeater circuits throughout the telephone plant. The repeaters which were shown on this sketch which was put in evidence remained in service in general in the Transcontinental line until about 1920. Single tube repeaters were also used at about the time of the opening of the Transcontinental line. Circuits were opened for the Pacific Telephone and Telegraph Company, connecting through from San Francisco to Los Angeles, with the repeater at San Luis Obispo in one direction; and also connecting north with three repeaters in the circuit. The single tube repeater circuits had M-type tubes like Exhibit No. 12, and also a resistance bridged across the input. One thing about Exhibit No. 12, the M-type tube was ordinarily made up with a base. The repeaters did use these M-tubes, and they had a resistance bridged across the input. The impedance of the plate circuit of the type M tube as used in these repeaters was of the same order as the impedance of the work circuit.

The negative voltage on the grid circuit has been used, I believe, on all subsequent repeaters. The use of a resistance across the input circuit to give a definite impedance has been used on at least most of the repeaters. The tapping off

304 *Burton W. Kendall—For Plaintiffs—Cross.*

of a portion of the voltage across this resistance has been used on most of the repeaters, and the matching of tube output impedance to the impedance of the work circuit has been used, I believe on all of the repeaters.

The opening of the Transcontinental line in January, 1915, attracted a very considerable public attention.

Cross Examination by Mr. Darby:

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I am familiar in general with the subject matter of the eight patents in suit. I know, in a general way, what the invention is of each of those patents. I think that the subject matter of each of those patents has been used by the Telephone Company in its telephone lines commercially since at least as early as September, 1915. And, I think, they have been used continuously since that time. They have been used in the ordinary commercial business of the Telephone Company in transmitting messages for pay between distant stations since September, 1915.

306

Before we opened the Transcontinental line we had a repeater station at Philadelphia, sometimes on the New York-Washington circuits and sometimes on the New York-Baltimore circuits. Repeater sets at Philadelphia for either of those. Vacuum tubes as amplifiers were used on an experimental basis as amplifiers at this Philadelphia repeater station. The repeater sets were not sold commercially. The repeater set was just a breadboard type of thing, just stuff wired up on an entirely laboratory basis, and was not—The traffic that went through that re-

peater was paid for right in New York, or paid for in Washington or Baltimore. In other words, they were used in the commercial transmission of telephone messages of your subscribers. About the earliest vacuum tube repeater at Philadelphia was about October, 1913. We employed a negative bias on the grid circuit, the vacuum tube repeater in this Philadelphia installation. After the date that was brought out in connection with that Philadelphia notebook, March 23, 1914. It was put in that morning. That repeater set was not changed back to positive bias. The repeater set was not in continuous operation, however. From that date on, I am prepared to say—that is, in March, 1914,—that the employment of a negative bias became a standard practice of our company. In our earlier repeaters the negative bias was obtained by a separate C battery. I think we did, in some repeaters considerably later, depart from the practice of using a separate source of current—that is, separate from our A battery source—for imparting a negative bias on the grid. I do not know just what time that came in. I know the subject matter that is referred to by the name Definite Input Impedance of one of the Arnold patents in suit. In our Transcontinental equipment we employed the definite input impedance arrangement in 1915, and have continued to use it since.

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Re-direct Examination by Mr. Ashton:

I stated that the repeater circuits that we were using in March, 1914, were sometimes used for paid conversations. They were continuously under the supervision of one of the members of

310 *Burton W. Kendall—For Plaintiffs—Re-cross.*

the Research Department while they were in the circuit. When he wished to leave to go out for lunch or to go home at night, a slide switch was thrown over, which threw the circuit over onto the Shreeve repeaters, which were also equipped at this point, and left on those during his absence. As to why this was done, the repeaters were in the circuit for the purpose of experimental observation on their operation on the circuit. The Shreeve mechanical repeater was being used regularly at that time in those circuits, in the New York to Washington and New York to Baltimore.

311

Re-cross Examination by Mr. Darby:

As to whether that situation prevailed insofar as the Transcontinental service is concerned, for a little time after the Transcontinental line was opened, for commercial messages, which was the latter part of January, 1915, engineers from the Research Department were out with the repeaters observing their operation. I was among them for some weeks myself. We had engineers at all the repeater stations for a brief time. A matter, I presume, of from two weeks to perhaps two months.

312

Q. So that by the end of March, 1915, the equipment was all O. K., and it has gone on happily ever since in its faithful operation, carrying paid messages from San Francisco to New York; is that right? A. Yes.

Lloyd Espenschied—For Plaintiffs—Direct.

LLOYD ESPENSCHIED, called as a witness on behalf of the plaintiffs, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is Lloyd Espenschied. I reside at 99 Newbold Place, Kew Gardens, New York City. My present occupation is high frequency transmission engineer, American Telephone and Telegraph Company. I was employed by the American Telephone and Telegraph Company in 1915 as a development engineer.

Radio telephone tests were conducted by the American Telephone and Telegraph Company and Western Electric Company in 1915. They were tests of long distance telephony, representing an attempt to project the voice across the oceans for the first time. The transmitter was located at Arlington, Virginia, just outside of Washington. The receiving stations were at New York, San Francisco, California, San Diego, Panama Canal Zone, Hawaii and Paris, France. In New York, Mr. Englund was in charge of the station; at Mare Island, San Francisco, Mr. Hartley; at San Diego, Mr. W. Wilson; at Darien, Canal Zone, R. H. Wilson, his brother; at Paris, France, Mr. Shreeve and Mr. Curtis; and at Honolulu, Hawaii, myself.

This paper dated May 26, 1915, is a description of the receiving apparatus employed at each of these points, a copy of which description I took with me to Hawaii. This paper was prepared in order that each of these engineers might have full information concerning the ap-

316 *Lloyd Espenschied—For Plaintiffs—Direct.*

paratus he was to use. It was given to the various men at the receiving stations.

I arrived in Honolulu in June, 1915.

This is a photograph of a radio receiving set, identical with the one which I employed in Hawaii.

Mr. Ashton: I offer the photograph in evidence as Plaintiffs' Exhibit 15.

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Mr. Darby: I object to it as irrelevant and immaterial.

Mr. Ashton: It is a picture of the receiver, your Honor, which this witness operated.

The Court: Objection overruled and exception.

(Marked Plaintiffs' Exhibit No. 15.)

318

The blue print ES160355, dated May 24, 1915, attached to the Wilson memorandum is a correct circuit diagram of the receiver which I operated at Honolulu. I received with my receiver at Honolulu wireless messages broadcast from Arlington, Virginia, in September, October and November, 1915.

At the left in the diagram is the antenna conveying the incoming signals, which connects through coil A to the ground. To the right are five vacuum tube stages constituting the detector and amplifying stages of the receiving set. The first stage is a high frequency amplifier; the second stage a detector or rectifier which converts the high frequency currents into voice frequency currents; and the next three stages are voice frequency or audio frequency amplifying stages.

Lloyd Espenschied—For Plaintiffs—Direct.

The so-called M-type vacuum tubes, such as Plaintiffs' Exhibit No. 12, were used in the audio frequency amplifier in the push-pull stage.

In the 1915 receiver, the output impedance of the third stage is substantially the same as the input to the transformer marked G. Likewise, the output of the fourth stage is substantially the same as the input transformer of the final stage.

The Wilson memorandum contains a reference to this on page 7 in the first paragraph. The output of the two audio frequency amplifier tubes was approximately linear, because the quality I received was good.

The 1915 receiver contained a resistance capacity coupling between the second and third stages. The output of the second stage terminated in a high resistance; I believe it was the order of 600,000 ohms. Across that resistance was taken a connection through a condenser, of about 1 microfarad leading into the next stage, which began with a similar high resistance connected across the input or grid circuit of that stage. This is referred to in the fourth paragraph on page 6 of the memorandum. I might correct the 600,000 ohms which I mentioned, to 400,000 ohms, which I note is the figure given. Some of the stages of the 1915 receiver had a resistance in shunt in the input circuit. Those resistances are given and referred to on pages 3 and 4 of the circuit specifications attached to the memorandum.

There was a variable potentiometer indicated as H in the input circuit of the second audio stage of the 1915 receivers for adjusting the portion of the resistance which is effective in the

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Lloyd Espenschied—For Plaintiffs—Direct.

input circuit. This is on drawing ES160355. The adjustability is also referred to on page 7 of the memorandum. This was for the purpose of controlling the loudness of the output of the receiver. In receiving signals at Honolulu I made adjustments for that purpose of the resistance H in the drawing. That is, for the purpose of adjusting the loudness of the loud-speaker output or headphone output in the case of using the headphones.

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The 1915 receiver had a common plate supply for the first stage, the high frequency amplifier, and the second stage, the detector, had in common the B battery marked D. An additional battery shown to the right of D was added to the second stage, but the first portion marked D was common to the two. And, similarly, the third and fourth stages had a common B battery as shown. The common plate supply is referred to on page 2, 4th paragraph, and also on page 4 of the memorandum. The statement that begins, "The connections of the plate circuit."

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At first, which was during the summer static season, I was unable to receive the signals at Honolulu but as the natural conditions improved, in the Fall, I received them very well. This tube looks like the D-tube used as the detector tube, I believe it was.

Mr. Ashton: I offer the D-type tube in evidence as Plaintiffs' Exhibit No. 16.
(Marked Plaintiffs' Exhibit No. 16.)

On October 22, 1915, I sent to New York from Honolulu a cable reporting successful reception,

Lloyd Espenschied—For Plaintiffs—Direct.

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and directed to the American Telephone and Telegraph Company, reading: "Heard well entire schedule." This referred to the schedule of tests. "Hello Shreeve." This is the quotation of what I heard: "Hello Shreeve. This is Webb talking." Then I went on and said, "Voice easily recognized." I am referring to refresh my recollection as to the exact wording of this cablegram to a copy of a newspaper article which appeared in the New York Times, Friday, October 22, 1915.

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Mr. Ashton: I now ask your Honor if you will receive the memorandum, the Wilson memorandum which was withdrawn and which I now offer again.

Mr. Darby: In view of the testimony of the witness, if your Honor please, I have no objection to the offer of that particular memorandum, but I accept the witness's statement as to everything he said in connection with it. I have no reason for questioning it, and I think under your Honor's previous ruling letting this evidence go in, that diagram would be admissible, I do not see any necessity for the rest of the material, because there is nothing contested about it.

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Mr. Ashton: In order to expedite it I did not have the witness quote from the memorandum at the various places that the patents are referred to. This memorandum has been in a number of cases, patent suits in this District, your Honor; it is in a number of records. I think that it ought to be received, because it explains

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Lloyd Espenschied--For Plaintiffs—Cross.

the whole receiver which the witness has talked about, and makes the record intelligible.

Mr. Darby: If I may say just one final word, your Honor, and then I will sit down. The fact that this document has been admitted in other cases, where it was perhaps admissible, is no reason why it should be admitted here.

Mr. Ashton: On exactly the same proposition.

329

Mr. Darby: I do not know anything about it, and I think this case is going to be disposed of on the admissibility of evidence presented to this Court. There is no dispute that the witness has stated as a fact what it incorporated. Mr. Ashton has asked him is that also referred to in the memorandum, and he said yes; but that does not add anything to the witness's positive testimony, which I do not question.

330

The Court: I will allow it.

Mr. Darby: Your Honor will allow me an exception.

The Court: Yes.

(Marked Plaintiffs' Exhibit No. 17.)

Cross Examination by Mr. Darby:

I don't know what became of this wireless telephone that was used at the different stations. I sent my own back to New York, to the laboratories. I myself was not physically located in the laboratories, so I lost sight of it. No commercial stations were established at that particular time at any one or more of these

various points where wireless telephone business was carried on; but this was really the beginning. There was activity following this, for the Government, which became very considerable during the war, and it was not until after the war that radio telephony became a commercial thing. This activity with the Government started before 1918, I believe starting in 1916. We started making tests for the Navy of radio telephony, and that work continued, as I recall it, right along, and of course burst into more or less flame during the war.

332

The Telephone Company of the Western Electric Company to my knowledge manufactured radio telephone equipment for the Government, especially aeroplane radio telephone apparatus during the war. I do not happen to know what was the earliest time that we manufactured equipment for the Government of this wireless telephone nature. It would be in that same general period. I do not know the exact time. Between 1916 and 1918. I do not know enough about the detail circuits to know whether that equipment likewise incorporates these various features that I have referred to. I mean the detail circuits of the equipment sold the Government. I have every reason to believe that many of these features were incorporated, because they continued on in the art thereafter. The equipment sold to the Government was with vacuum tube amplifiers, of course. Wherever a vacuum tube amplifier is employed you encounter problems of distortion.

333

This work done with wireless telephony was done about the same time, as I recall it, as the

334 *Lloyd Espenschied—For Plaintiffs—Cross.*

installation of the Transcontinental telephone service. The Transcontinental line was opened at the beginning of 1915, and the beginning of these tests was approximately the same time. By that I mean we had preparatory tests over shorter distances ahead of these tests. The tests concerning which I have testified, transmitting to Honolulu started really in May and June, 1915, and I believe our Transcontinental line was in commercial service in January, 1915,
335 according to the testimony that Mr. Kendall gave yesterday.

The Telephone Company is not directly the manufacturing concern. The Western Electric Company is—represents that function. The Western Electric Company manufactures the equipment and sells it to the Telephone Company for its commercial use—that is, the equipment in general. The equipment that was employed in these Honolulu tests was made in the laboratories of the Western Electric Company. The Western Electric Company likewise made
336 the apparatus that was used in our Transcontinental telephone service as a part of their laboratory facilities. Neither that apparatus nor that first experimented with on the line was commercial apparatus, you appreciate. I am referring to the experimental service between New York and Washington.

Q. But when you established your Transcontinental service in the early part of 1915 and used it for the commercial transmission and reception of telephone messages for pay, that was commercial apparatus, wasn't it? A. I was not sufficiently closely in contact with it to know just what its status was.

Raymond A. Heising—For Plaintiffs—Direct.

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Q. Were you sufficiently closely in contact to know that the Western Electric Company manufactured that equipment with the knowledge of the American Telephone and Telegraph Company? A. No, I do not know.

RAYMOND A. HEISING, called as a witness on behalf of the plaintiffs, having been duly sworn, 338 testified as follows:

Direct Examination by Mr. Ashton:

My name is Raymond A. Heising. I reside at 232 Oak Ridge Avenue, Summit, New Jersey. I first entered the employ of the Western Electric Company in July, 1914, in the research department. I was responsible for the design of the electrical circuits and the construction of much of the apparatus which was used in the radio transmitter station at Arlington, near Washington for the 1915 radio telephone test.

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This memorandum and drawing and photographs attached thereto were compiled by myself.

A common plate supply was used for two successive stages, known as the modulator and the first amplifier in the radio telephone transmitter.

The power amplifier represented on the right, consists of a large number of tubes operated in parallel. We used as high as 550 tubes in parallel at one time. They got their plate supply from the generator located nearby, marked 600 volts. The plate circuits were connected in parallel and

340 · *Raymond A. Heising—For Plaintiffs—Direct.*

connected to the oscillation transformer, which delivered the power to the antenna. We wished to get as much power as possible in these tests. The only generator available at Arlington was the 600-volt generator, and the amount of power which we could get out of a single tube operating on 600 volts was, of course, determined by the voltage. We therefore used as many tubes in parallel as we were able to construct, so as to get into the antenna a power equal to the sum total of the power delivered by the various tubes.

341 At times, we made the impedance of the load equal to that of the tubes in parallel. Later, after I had measured the antenna resistance and determined that better quality would be secured by coupling closer, the impedance attached to the tubes was made somewhat higher than the impedance of the tubes in parallel.

Negative grid bias was used in each case of the power amplifiers. It is represented by a battery marked 175 volts E_c.

342 Operation of the Arlington transmitter operated for the 1915 tests began the first few days in July, and continued most of the time with two or more tests daily until October, 1915.

This photograph entitled "Power Tube" is of one of the power tubes used in the transmitter. The photograph was taken against the outside of the building in which the equipment was housed. My memorandum correctly describes the other photographs attached to it.

This is a tube of the same general character as the power tubes used in the transmitter. It is constructed with the electrical characteristics, with the plate filament and grid construc-

Raymond A. Heising—For Plaintiffs—Direct. 343

tion and spacings which were used in those power tubes, and no doubt the same sized glass envelope, but the manner of spacing and separating the elements inside is not identical. Some of the tubes used in the transmitter had bases, as is shown in the photograph of the power tube. Some of them did not have bases, but were used in the form in which this one actually occurs. This particular tube was made about 1916. The power tubes in Arlington of the same kind were called type W tubes. The tube which I have been looking at is a type W tube.

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Mr. Ashton: I offer the tube in evidence as Plaintiffs' Exhibit No. 18.

Mr. Darby: Objected to as irrelevant and immaterial.

The Court: Objection overruled and exception.

(Marked Plaintiffs' Exhibit No. 18.)

By Mr. Ashton:

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The memorandum to which I have been referring was prepared November 19, 1930, by me for the purpose of making a permanent record of the photographs, circuits, and so on at that time; 1915.

Mr. Ashton: I offer the memorandum and photographs in evidence as Plaintiffs' Exhibit 19.

Mr. Darby: I object to that as irrelevant and immaterial,—not having any bearing on any issue of the case, in view of my statement that I have no occasion to ques-

346 *Raymond A. Heising—For Plaintiffs—Cross.*

tion any of the facts stated by the witness in this examination.

The Court: Objection overruled and exception.

(Marked Plaintiffs' Exhibit No. 19.)

The photograph marked "Power Tubes" was taken in 1915, during the course of the operation of the radio transmitter. It shows the type W tube as actually used.

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Cross Examination by Mr. Darby:

At the time that I designed this equipment for use at Arlington, I believe it was standard practice with us in our commercial apparatus employing more than one vacuum tube, to use a common source of current for the plate electrodes for the tube. I do not believe I ever used the positive bias, and I heard no talk about that. I heard Mr. Kendall testify yesterday. That is the first I heard that they used positive bias.

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When I first put a bias on the grid, I did that by including in the circuit [redacted] between the grid and the filament a small battery. I think it probably expresses it to say that when we used a negative bias by means of a battery, we merely would break the line or conductor from the grid to the filament and insert a battery in there. And whether or not a negative or a positive bias was put upon the grid would depend upon whether or not the connection leading directly to the grid was connected to the positive terminal or the negative terminal of a battery. So that in connecting a battery between the grid and filament circuit of an audion tube, you had

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one of two possible connections, either connecting the grid to the positive terminal of a battery or to the negative terminal of a battery.

Re-direct Examination by Mr. Ashton:

I said I came with the Western Electric Company in July, 1914.

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FRANK N. WATERMAN, resumed:

Direct Examination by Mr. Ashton (Continued):

Q. Now, will you take up the Lowenstein patent? A. The Lowenstein patent goes to the provision for an audion tube of a means for biasing the grid to a potential ultra-negative with respect to the filament. That is to say, the grid is given a potential relative to the filament more negative than any part of the filament.

The invention is described in connection with a telephone circuit, and the upper part of the figure of the drawing shows the ordinary local wiring telephone station.

When the telephone is on the hook 3 shown at the left, the circuits 7 and 11 are broken and the only circuit existing through the system is that through the bell 4 at the right, and the condenser 5. This, as the patent explains, is due to resonating with the ringing frequency, and, therefore, having a comparatively low impedance to the ringing current coming in. When the receiver is taken from the hook, the hook 3 rises

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and the circuit is closed at 7, so that the incoming line 1 may be traced through the primary of the transformer 6, thence through the hook 7, thence through the microphone 8 and out on the line 2. A secondary 9 of the transformer connects through the contact 11 also closed when the receiver was taken off from the hook and its circuit goes through the coil 12, which, in the ordinary receiving station is the telephone itself; thence through the winding 9 and through the condenser 5 to the line 2.

353

To connect the audion to the line, Lowenstein replaces the telephone by a transformer whose primary 12 is connected in place of the telephone, and to secondary 13 is connected the input circuit of the audion, one end going to the grid 18 and the other end going in directly to the filament as in the diagram Exhibit 5, I believe, going to the negative end of a battery.

354

The tube is provided with a heating battery 19 adjustable for correct temperature of the filament by resistance 20. From this battery 19, the current flows to the resistance through the portion thereof that is included, as indicated by the arrow, thence through the filament 16 and back to a battery. The plate circuit of this tube may be traced from the battery 21, the adjustable point being indicated so the number of cells may be varied through the receiver. The specification states a transformer primary, in case that is used, as shown, to the plate; thence the current flows to the filament and back to the battery 21. Battery 21 is shown as a single group of cells, and the connection of the filament and the plate are indicated as adjustably connected

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so that the plate voltage and the grid voltage may be adjusted.

The effect of putting on the negative bias is to introduce into the electrostatic field otherwise existing between plate 17 and the filament 16, what we might call a low spot. It is made negative with respect to the filament, whereas the plate is strongly positive with respect to the filament.

Before going into further description of the effects produced, I will refer to the specification. At line 11, page 1, Lowenstein points out that his object is "to provide a relay by means of which the relation of the potential differences of the complex incoming speech current is well maintained in the telephone receiver so that the sound reproduced by the receiver diaphragm will be composed of waves of practically the same frequencies as impinge upon the transmitter diaphragm."

356

What he says he considers most important is that these various frequencies will have about the same relative amplitudes as the original sound waves actuating the transmitter. The result being freedom from distortion and intelligibility of speech.

357

He then points out that when a line carries current, a current is drawn from the line to operate a receiver, distortions occur as a result of voltage losses occurring in the line, as the result of the flow of the current.

He points that if the line can be operated without the relay device drawing current from it but a relay using it responds to the terminal voltage of the line and accurate reproduction can be ef-

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Direct.*

fected. Without reading all the description, he says, beginning at line 50: "Therefore a relay apparatus which functions according to terminal voltages is well adapted for the production of receiver operating currents of the desired absolute strengths and in the relative strengths necessary for the successful operation of the telephone receiver."

359 Q. Is that what the Court of Appeals was referring to in the opinion where it said: "This invention consisted essentially in the discovery that if the grid of a vacuum tube amplifier is made to operate by potential and not by current the distortion produced in the input circuit by current (and reproduced in amplified form in the output circuit) could be prevented, and that this restriction to potential operation could be attained by the application to the grid of a suitable initial negative potential on which the signals to be amplified are superposed." A. Yes.

360 The Court: What page is that?

Mr. Ashton: Page 3 of the printed copy, second paragraph under the heading "Lowenstein patent."

A. (Continuing.) What Lowenstein accomplishes by the application of the negative grid bias is just what is referred to in this last quotation, beginning at line 50, page 1 of the patent. He converts the audion into a device which operates purely by voltage without drawing any current. I have pointed out that the heating of the filament 16 produces a sort of cloud of electrons around the filament. In order that they

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may be drawn across to the plate, it is necessary that the so-called B battery be provided, which gives a positive potential to the plate 17; thereupon the electrons flow across like a swarm of bees passing from the filament to the plate. That constitutes a current, perhaps the same electrons continue on through the circuit flowing in the reverse direction to the nominal flow direction of the current. But that is not known. At any rate, the electrons carrying the electricity across constitute the only flow taking place in the tube.

362

If instead of making the plate 17 positive, it were made negative, the effect would be to tend to drive the electrons back into the filament and no current would flow across the space. When, therefore, Lowenstein made the grid, interposed between the two elements, filament and plate, negative by connecting to the so-called C battery, the negative end of the so-called C battery, he interposed a force tending to drive the electrons back into the filament, and he effectually prevented any electrons from attaching themselves to the grid and constituting a current flowing in the input circuit. Therefore, the application of this negative bias converted the audion from a device taking current in its grid circuit to one whose grid circuit was rendered impervious to current. Therefore, he converted it into a potential operated device in the strict sense, that its grid circuit will not draw current from the line unless the signal voltage brought in by the line exceeds the negative bias imposed by the battery C. What that means, your Honor, looking at Exhibit 6, for example, is, if we take the idea

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of these irregular peaks constituting sound waves, the height above the mean or zero line which would lie through the middle of the curve, as representing the voltage brought in by the line, so long as the voltage of the battery C exceeds these instantaneous high peaks, then the grid will continually remain negative and current will not flow in the grid circuit. The device becomes a purely potentially operated device.

365 Referring to the specification at page 1, line 106, after describing circuit arrangements, Loenstein says, "The potential created in secondary 13 (due, of course, to the current coming in on the line) are made to control the current flowing through the ionic field and originating in battery 21"—I think I have explained that the electrons passing from the filament to the plate, each being a negative charge of electricity, sets up a field of its own, at the same time that it is traveling on the electrostatic field other than by the plate. The expression "ionic field" merely means a space in which ions are traveling and the term "ion" is a broad term for any particle carrying an electric charge. It may be merely an electron; it may be an electron attached to an atom; it may be an atom that has lost an electron, and, therefore, carries the positive charge. The term has this broad meaning. As referring to the successful operation of the audion, it means what we call electrons or negative charges.

He speaks of the current as originating in a battery. Of course, it does. The energy supplied comes from the battery and the battery is regarded as a source of current, notwithstanding

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the fact that the electrons that carry it in the space have been boiled out of the filament. Continuing, the quote says: "originating in battery 21 by connecting the one terminal of coil 13 to the modulating member 18." That is the grid. He continues: "and the other terminal of said coil to a point on the battery 21, which is located ultra-negatively relative to the negative point of the battery connected to the filament."

The battery connected to the filament (battery 19) is connected to a battery 21 as indicated by the arrow, and what this statement means is that while one end of the coil 13 is connected to the grid, the other end is connected to a point on the battery, ultra-negative with respect to the terminal of the battery of the filament. In other words, another way of saying that would be that the filament has its negative end connected to the battery 21 at a point positive with relation to the connection of the return end of the grid circuit. The positive end of the battery 21 is indicated at the left by an arrow in the patent drawing. Each cell of the battery has a positive terminal and a negative terminal. By moving the filament connection along on this battery, any number of cells can be included in the plate circuit. Similarly any number of cells can be included in the grid circuit. As the specification points out, these adjustments are necessary to bring about the correct relations.

Continuing the reference to the specification, at page 2, line 3, it says:

"This ultranegative connection is especially desirable and constitutes an impor-

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tant feature of my invention in its preferred embodiment. The volume and clearness of speech as heard in the receiver in the arrangement shown is materially greater than where the grid 18 and coil 13 are connected, for example, to a point at the same potential as the filament 16."

371 The contrast being with a connection in which the wires returning the grid circuit to the filament were connected to the same point; or, in other words, on this diagram the wires G and F were connected together. At line 18, he says:

"Both the positive and the ultranegative points of connection to battery 21 are adjustable to enable variation of the driving potential of battery 21 for the ionic field and of the ultranegative potential."

372 Actually what the drawing shows is that the C battery is adjusted by varying the wire that leads to the positive end and the plate battery is similarly adjusted by the wire that leads to its positive end. In this way operation in response to incoming signals is effected without drawing current from the telephone line, and in response only to the potential variations.

Mr. Ashton: I offer the diagram, which is a copy of a portion of the Lowenstein drawing with the addition of red lettering to indicate the various elements, as Plaintiffs' Exhibit No. 20.

(Marked Plaintiffs' Exhibit No. 20.)

The Witness: The insertion of the battery C, as shown on Exhibit No. 20, requires a readjust-

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ment of the battery B if the same current is to flow in the plate circuit as flowed before the insertion of the battery C. In other words, the grid bias makes it more difficult for the electrons to get across. The higher positive voltage on the plate 17 is required to bring that about. This seeming disadvantage is in fact a very great advantage, because it has the effect of shifting more of the actual available useful range of the audion into the region where negative operation or operation of the grid negatively is possible.

374

It therefore not only increases the faithfulness of repetition due to the line, but also to some extent the faithfulness of the repetition due to the tube. It increases the tube's capacity to operate effectively—that is a better way to put it—permitting the use of higher plate voltages.

If we take as zero the point where the arrow attached to the line F is connected—that is, taking that as the negative terminal of the battery B—then the farther the arrow P is moved to the right, the higher the positive potential with reference to that base or zero point for the filament. Now, as we go the other way, the farther we go the more negative would the wire G become.

375

The specification points out that the resulting operation of the audion is an operation which so far as the input of the tube is concerned is substantially energyless; no energy is drawn.

Q. What line are you referring to? A. I am referring particularly to page 2, lines 68 to 90. He says:

'By providing a modifying or controlling device, such for example as the modu-

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lating means 18, which is subjected to an impressed potential more negative than that of the cathode and which is adapted and arranged to interpose between the anode and cathode modifying or controlling field of the desired character, the potential gradient between the filament and the controlling device or modulating means may be changed and thereby the current which flows through the ionic circuit changed accordingly."

Is that expression "potential gradient" clear to your Honor?

The Court: No, it is not.

378

The Witness: We can illustrate it by using the analogy of a geographical gradient. We might say, for example, that at the top of a hill we have a certain gravitational potential; at the bottom we are a little nearer the centre of the earth and we have another gravitational potential. This slope from the top of the hill to the bottom would represent the potential gradient. That concept is used as applying to electrostatic fields. The plate 17 is positive. In the ordinary sense of our terminology, it is, therefore, at a higher potential than the filament 16. That potential decreases all along the space. If we had merely the battery B, the filament not heated, the grid absent, we would have a substantially uniform potential gradient all the way down.

Now, as soon as the filament begins to emit electrons, a negative area is created around the

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filament and the gradient is no longer regulated. It comes down more steeply. The gradient from the plate to the bend may be regarded as uniform to the outer edge of this halo of electrons. When we put the grid in and give it a negative bias, then we put a hollow in the middle of our gradient, so to speak, and the gradient now runs from the plate to the grid, which is even at a lower potential than the filament.

So that we have a very irregular potential gradient between the two, and that irregularity is capable of rapid adjustment by the incoming signal applying its potential to the grid. That is the concept that the patentee is using.

He continues:

"By applying variable potentials to the modulating means 18 the currents in the ionic field circuit are varied accordingly and as the impressing of a potential on conductor 18 need not be accompanied by an appreciable expenditure of energy, whereas the energy of the ionic field circuit is varying considerably, I have a means to produce great changes of energy in that field circuit by variation of potentials which do not require appreciable energy."

In other words, from the energy standpoint he is getting enormous amplification. He is taking no appreciable energy; he is getting out a large amount of energy, the value of which is determined by the battery and the number of electrons emitted, et cetera. That particular question we are coming to in a later patent.

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Q. Is this matter of the poling of the A battery dealt with by the Court of Appeals in the opinion at page 5, running over on page 6 (handing witness book)? A. Yes.

Q. Will you point out briefly what is said by the Court of Appeals there? A. The Court points out that in the case before it a controversy arose over the meaning of the passage beginning at line 106 of page 1 and extending to line 3 of

383 page 2. It was contended in that case that the expression "located ultranegatively to the negative point of the battery connected to the filament" did not mean ultranegatively with respect to the battery 19, but meant negatively with respect to the arrow indicated on Exhibit No. 20 by the letter F. Therefore, it was argued that the terminal of the battery 19 connected to F might be the positive terminal.

If that were the case, then connecting the wire G of Exhibit No. 20 to the negative end of battery 21 would not make the grid negative, unless

384 it happened that the battery C had more cells in it than the battery A, and that in the event that it did have more cells than the battery A the grid was not necessarily negative to every part of the filament.

Q. Will you explain that difference in potential from one end of the filament to the other? A. The potential difference between the terminals of a battery is exactly matched by the fall of potential in the external circuit. If the battery A has, we will say, a potential of 6 volts, then the point where it is connected to the resistance 20 will also have with reference to the negative end a potential very nearly 6 volts, because it

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takes very little voltage to force a current through that simple wire. But when it comes to resistance 20, that as its name indicates requires some considerable drop of pressure.

By the time, therefore, that we got to the left hand end of resistance 20 the potential at the other end of the battery might be only 5 volts. The useful work of the current is being accomplished in heating the filament. The filament would not be heated except that it has resistance. Therefore, the 5 volts which I have assumed exists at the beginning of the filament 16 would be all consumed by the time that the current gets back to the negative end of the battery.

If, therefore, there is a drop of five volts in the filament 16, and if the negative bias were, say, 7 volts, then the grid would only be negative with respect to so much of the filament as consumed 2 volts. It was the contention that the statement was indefinite and that "ultranegative" did not mean more negative than the most negative part of the filament, but only more negative than some part of the filament.

The Court of Appeals discusses that contention, and in view of statements made in the prosecution of the case finds confirmation for its interpretation of the specification the other way—that is, as meaning that the connection is located ultranegatively with respect to the negative end of the battery 19 connected to the filament.

Q. Will you point out the location of the Lowenstein invention in defendant's circuits, and explain how that negative potential is applied to the grid? A. Referring to Plaintiffs' Ex-

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hibit No. 2, the grid of the vacuum tube V-1 in the amplifier A-41 is connected through the resistance L to the bottom end or lower end of the resistance R-1. The current which heats the filament of the tube V-1 comes from the battery A and flows through a regulating resistance corresponding to the resistance 20 of the Lowenstein patent, thence through the filament, thence back through the resistance R-1 to the negative terminal of the battery.

What happens, therefore, is that a part of the battery voltage is consumed in the first resistance, and another part is consumed in the filament, and the remainder is consumed in the resistance R-1. The point to which the grid is connected, namely, the lower end of the resistance R-1, has substantially the voltage of the negative end of the battery. The top end of that resistance which is connected to the filament has a considerably higher voltage, because of the loss of voltage occurring in the resistance R-1.

390 Therefore the filament in the tube V-1, looking across at the grid, sees the grid negatively biased with respect to itself by the amount of voltage that is required to force the current from the filament back to the battery.

I may state that this drawing is made in accordance with a conventional illustration of the audion that is not infrequently used where for the sake of orderly succession of connections through the circuit the grid is shown at the left side of the cathode while the plate is shown at the other side. But that does not indicate any structural difference. It is actually placed be-

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tween the plate and the filament in the mechanical structure.

The resistance R-1, therefore, constitutes the means by which the tube V-1 is negatively biased. Exactly the same sort of bias arrangement is provided for the tube V-2, the resistance R-2 being in this case that which provides the bias, and the grid of the tube V-1 is connected through the lower portion of D-1 to the lower end of the resistance R-2. 392

The vacuum tube V-3 of intermediate amplifier A-36 is biased in a little different way. In this instance the tube V-3 has what is known as an indirectly heated cathode. It is a tube known to the trade by the number 227. Its filament is not the direct source of the electrons. The filament is what is known as a heater which heats an envelope surrounding itself, indicated by the little hooked line in this diagram. It is otherwise known as a unipotential cathode tube, because there is no difference of potential anywhere along it. The difference of potential which I explained occurs in the filament of a tube is sometimes a disadvantage. Particularly is that the case when there is the possibility that the heating current may itself vary some, and where the heating current is derived from an alternating current circuit it becomes a matter of very great advantage to not have the heating current flow in the cathode itself at all. Therefore, the unipotential cathode heated merely by radiation from a little heater contained inside of itself is employed. 393

The plate current flowing through the tube V-3 can be traced from the Power Pack P-32, the

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connection just at the left of the letter E. It flows up through the coil G-1, the coil G-2, to the plate; thence across to the unipotential cathode, thence down through the resistance R-3, thence to the right and down to the negative end of the resistance—that is to say, the left hand end of the resistance indicated by the letter E.

395 In an exactly similar manner the entire plate voltage which is provided by the Power Pack P-32 is expended in this external circuit. If the voltage, for example, is 100 volts, some little portion of that is expended in G-1 and some small portion in G-2; most of it is expended in the space between the plate and the cathode of the tube V-3, what is left is expended in the resistance R-3. It reaches the negative or for this purpose zero terminal of the supply. The grid of the tube V-3 is connected through the transformer secondary S-3 and through another resistance to the lower end of the resistance R-3. It therefore is more negative than the cathode by the amount of voltage required to force the plate current through the resistance R-3.

396 The tubes V-4 and V-5 of the intermediate amplifier A-36 are biased in a precisely similar manner, although the method of illustration is necessarily a little different. These two tubes V-4 and V-5 are tubes of the filament type and are operated in parallel from a circuit derived from the Power Pack P-32. That is to say, the two conductors come up and connect to the filaments in such manner that the current divides going through the filaments of the two tubes, unites again and returns to the supply. Across

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these two conductors there is connected a T-shaped resistance arrangement R-4. This resistance consists of a branch connected across the two wires which continually carries a certain amount of current corresponding to the filament current. The centre point of that resistance represents the mean potential point of the entire cathode. That means this: starting from one end of the filament the current flows through to the other end. If the drop of potential through the filament is, say, 6 volts, there will be 3 volts of that lost to one end of the filament and the other 3 volts lost to the other end of the filament.

If we now put a resistance across the conductor carrying that current, there will be equally 6 volts lost across that resistance. By tapping a suitable point at the middle we can find a point which has the same potential as the middle of the filament. The reason that expedient was adopted is that the filaments of those tubes are heated not by direct current but by alternating current. The noise that that alternating current would set up in the filament would be terrific if the connection were made to one end of the filament. It is therefore necessary to get a point in the filament whose potential does not vary: That is the mean point, because whichever way the current is going through the filament the mean potential point remains the same.

Therefore, the actual biasing resistance of this group of resistances R-4 is connected to that mean potential point, and the plate current going in this instance from the right hand terminal of the resistance E, passes through G-3 to the

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middle point of the transformer secondary P-5. There it divides, one half of it flowing to the plate of V-4 and the other half to the plate of V-5. It then flows through the tubes to the filament, out the two sides of the filament, through the resistance to the middle point which is at the top end of the lower branch of the resistance R-4. Thence it flows through R-4 and back to the left hand end of the resistance E in the power pack P-32. Here again it is the voltage loss in the resistance R-4 which is impressed upon the grid. The plate current flowing across to the filament after passing through the resistance R-4 leaves the filament at a higher voltage than the lower end of the resistance R-4.

The grids of the tubes V-4, V-5 have the same potential as the lower end of the resistance R-4, because no current is flowing through them, therefore no voltage is consumed. So the grids of those two tubes are given the ultranegative bias.

402 Q. Is the same also true of the PA-39 amplifier by means of the resistance R-5? A. Yes, and it is accomplished in exactly the same manner, although in this instance it is the center of the transformer which is tapped. That is, the transformer is so tapped as to take out a potential equal to the mean potential of the filaments; because in this instance no resistances are interposed in the least. This means that when this PA-39 amplifier is wired up equal lengths of conductors are taken from its two terminals to the two filament terminals. They therefore have the same potential essentially as the terminals of the transformer. In order

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to get the potential which is the mean potential of the filaments, it is only necessary to find that point in the transformer, and that is what is done. Then the resistance R-5 is connected in a lead going to the plate circuit.

The current in this instance for the plate circuit comes from the top end of the filter F-2 of the power supply apparatus associated with the amplifier PA-39. It flows to the midpoint of the transformer primary P-6, divides, flowing to the two plates of the tubes V-6, V-7, through the space to the filaments down the two leads to the secondary S-11, to the middle point, up through the resistance R-5 to the right and over to the negative end of the filter F-2, which is at the left.

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The grids of the tubes V-6, V-7 are connected to the low potential side of the resistance R-5, namely its top end, by a center tap in the secondary S-5 of the input transformer. The grids, therefore, have the potential of the negative end of the supply, while the filaments of the tubes have a potential as much higher as the loss of voltage in the resistance R-5.

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Q. Will you now take up the Mathes patent, and particularly Claim 8—Claim 8 being relied upon as to the A-41 amplifier only? A. The Mathes patent discloses a simple method of producing the bias for the grid without the addition of a special battery for the purpose. In Fig. 1 two batteries 6 and 5 are shown; or, otherwise looked at, the single battery with two sections 5 and 6. The tube 1 has its plate 4 supplied from the positive end of the section 5, while the filament is supplied with current from the

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section 6, and flows from the positive or right hand end of the battery 6 up through the filament 3, thence to the left through the resistance 9, thence down through the regulating resistance 15, thence through the choke coil 14 back to the negative end of the battery. The total potential of the battery 6 is expended in this external circuit, part of it being lost in the filament 3 and part in the resistance 9, and the balance in the devices 14, 15.

407 The result is that the left hand end of the resistance 9 is at a lower potential than the right hand end, and therefore at a lower potential than any part of the filament 3. The grid 2 connects through the lower half of the resistance 10 to the left hand end of the resistance 9. The grid, therefore, has impressed on it the potential of the left hand end of the resistance 9.

408 This drawing shows the batteries 5, 6 as provided with charging means. The arrangement contemplated is that the amplifier is operated, for example, at a relay station where there is a large battery used for other purposes. This battery is tapped off suitably for the purposes of the amplifier, but since the battery is a general purpose battery it is charged in regular routine, for example, perhaps once a day. When the switch, which is not lettered but is just to the right of the numeral 19, or about an inch to the right of numeral 19 in the drawing, is closed and the generator indicated by the numeral 19 is in operation, then the battery is being charged and current flows in to the right hand terminal of the battery 5, thence through the battery 6 and back to the other terminal of

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the generator. This has the effect of raising the voltage of the battery. At the same time it would raise the current through the filament. But also at the same time it would increase the bias on the grid, because more current would be flowing through the resistance 9. There is, therefore, a compensating effect due to the increased drop in the resistance 9 to offset the rise in voltage of the battery 5 and increased current in the filament 3.

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In other words, when the voltage of the batteries 5 and 6 rises and therefore the plate current in the tube tends to rise due to the increased plate voltage and the increased filament temperature, the bias due to the resistance 9 increases; the grid becomes more negative, which tends to restore the condition. In other words, as the patentee points out, there is a partial compensation to fluctuation in voltage in the battery. I might add that this is also true for momentary fluctuations as well as for large well maintained changes that occur in charging. The generator 19 is likely to produce some pulsations. The purpose of the choke coil 14 is to exclude those pulsations from its circuit, the choke coil acting to develop a high impedance to variable current, although having almost no resistance to a constant current. Would you like to have that explanation, or will your Honor just take it as it is stated?

411

The Court: I do not believe that will be questioned, will it?

Mr. Ashton: No, your Honor, I do not think it is necessary.

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The Witness: It may be necessary to explain it in connection with some other later patent.

Mr. Darby: May I say for your Honor's guidance that we are not questioning anything in connection with the description of the patents. So that anything Mr. Waterman says about them will be accepted. That might possibly expedite it a little bit.

413

The Witness: That is, in substance, the disclosure of the Mathes patent insofar as the description of Claim 8 goes.

414

Q. Do I understand you to say the advantages which you have referred to, particularly this compensating advantage, is an advantage over the invention of the Lowenstein patent? A. It provides an advantage over the Lowenstein patent where the voltage supplies may be variable. It attains in other respects the same result as the Lowenstein patent in a simpler way.

Q. It eliminates the necessity of having the third or C battery? A. Yes.

Q. And that is referred to in the Bunnell opinion on page 7, where the Court states, "The A battery is used for biasing the grid, thereby eliminating the C battery?" A. That is correct. I might point out that the specification of the Mathes patent beginning at page 1, line 27, states that such fluctuations are troublesome. I have not thought it necessary to go into the explanation of the various effects produced, but it points out that such variations are troublesome and the partial compensation resulting in a measure removed that.

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415

The patentee goes on and in another figure shows and in the specification describes means of making the compensation more exact. For example, at the bottom of page 1, line 109, he says that: "By the variation of the character of resistance 9, more exact compensation can be obtained."

He then goes on to suggest that the resistance might be one which varied its own resistance with the flow of current through it. There are resistances, for instance, which can be made to increase very rapidly when a little more than a normal current flows through them, and that would produce a compensating effect in one way. In Fig. 3, he shows a tube device 15 which will decrease its resistance when current flows through it. Those are not involved in the defendant's apparatus and I had not thought it necessary to dwell upon them.

Q. Did you refer to page 1, lines 27 to 32?
A. Yes, I did.

Q. Now, as I understand your previous testimony with regard to the resistances R-1, R-2, R-3, R-4 and R-5 in defendant's circuit, these are the resistances in the grid filament circuit in each of these stages of the defendant's amplifier, is that correct? A. The resistances R-3, R-4 and R-5 are in the plate filament circuit and also in the grid filament circuit. The resistances R-1 and R-2 are in the filament circuit.

Q. That is in the A-41 amplifier? A. That is in the A-41 amplifier.

Q. Those are the resistances which are covered by claim 8 of the Mathes patent? A. As a matter of technical description, claim 8 reads on the

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amplifier A-41, having in mind the resistances R-1 and R-2 which are contained in the filament circuit and also in the grid circuit.

Q. Now, will you take up the Arnold Patent No. 1,329,283, the power circuit patent of which claims 7, 10 and 13 are relied upon, as to the power amplifier PA-39, in defendant's circuit?

419 A. This Arnold patent No. 1,329,283 goes to the constitution of an efficient power circuit arrangement whereby the final stage in the amplifier, or for that matter, any other stage if you choose to use it, may be made to efficiently deliver power to the end of obtaining maximum power.

The specification starts with a rather extended series of definitions and discussions of the device, that I think perhaps it will be necessary to explain. I believe that all of the terms used in the first two or three paragraphs have been defined. I shall refer to line 15, however, where it says: "This object (namely the production of audions with any desired characteristics) is accomplished by proportioning the geometrical and electrical relations of the various elements of the device in a manner more fully explained later in this specification."

420 It will perhaps be necessary to use that expression "geometrical" or "the geometry of the tube" merely as referring to its special relation to the size of its element and the mode of construction of the grid and the like. Those are all comprehended broadly under the term "geometrical."

Beginning at line 28, it is said: "The thermionic amplifier consists of a hot electron-emitting cathode, such as the so-called 'Wehnelt' cathode,

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of a cool anode and of an auxiliary electrode called the grid, which is usually, though not always, located between the anode and the cathode."

The Wehnelt cathode is a strip of wire or conducting material,—platinum used to be used, although baser metals are used nowadays to a considerable extent, and coated with the oxides of some of the rarer metals, such as barium and strontium and the like, which have apparently a particularly loose hold on their electrons. They emit electrons very freely and at quite low temperatures. That accounts for the fact that some of the tubes, such as perhaps your Honor has noticed, do not give a very bright glow, and such tubes have what is known as the Wehnelt cathode, in which the electrons are emitted from a coating of barium or strontium or a similar metal in the form of oxid placed upon the actual filament conductor.

422

The patent then points out that the plate battery is employed to force the electrons across the anode, thus setting up a convection current (line 36), the convection current carried by electrons in the evacuated space. The word "convection" is used in physics to mean the transfer by particles, one at a time, as for instance, we speak of the heat by convection, for example, the heating up of the air adjacent to a radiator, which moves on and its place is taken by another particle; in the tube, we have electrons carrying one charge, and another carrying another charge, and the "swarm of bees" figure is sometimes used to picture the convection current that the patentee refers to.

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Skipping to line 44, the following statement is made: "Due to the presence of those electrons, a negative space charge is established between the anode and the cathode, whose effect is to limit the number of electrons which can leave the cathode, and consequently to limit also the current which can flow in the output circuit, by which is meant the circuit including the battery and the path of the space current."

425 I think I have already defined all the ideas that are involved in that. Each electron being a charge, contributes its portion to building up a space charge. Each electron in its motion across from the filament to the plate is reacting back on other electrons, tending to prevent their coming out. When enough of them are en route between the filament and the plate, no more will come out.

By the Court:

Q. A case of overproduction? A. Overproduction. This is the condition of affairs when no signal is coming in. With calls, the plate signal, —the current in the plate circuit rises to a certain value and stops. It stops because of this action of the space charge. He goes on: "The object of the grid is to furnish a means for introducing a further negative charge into the space between the anode and the cathode, or for introducing into it a positive charge which shall neutralize the effect of part of the space charge due to the electrons."

All of this latter portion, beginning there at line 44, reciting the object, Arnold, as far as I know for the first time introduced this, and this

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was a new doctrine. The operation of the tube had been a complete mystery. This elucidation was brought about by the work of Dr. Arnold. The conception of the space charge was quite a novel one. It has become standard terminology in the art, but it was wholly new, as Arnold initiated it, as I understand it. At least I am not familiar with its being found elsewhere. So Arnold points out that the grid serves as a means of introducing a further negative charge or for introducing a positive charge into the space. That I have already explained in connection with the discussion of the simple audion diagram. Arnold goes on (line 59): "In the first case, the convection current is decreased; in the second it is increased. In order to force this charge to the grid, a source of electromotive force is connected between grid and cathode, that is, between the input terminals of the device. The effect of such an impressed electromotive force is therefore to alter the magnitude of the space current in the amplifier by changing the distribution of space charge between the electrodes, and moreover this is accomplished without requiring that the impressed electromotive force shall do more work than that involved in forcing the charge to the grid against the counter voltage of the condenser formed by grid and filament."

I have already pointed out that any two conductors that are insulated from one another, are regarded as a condenser. To establish a difference of potential in the conductor, a very minute amount of electricity must be forced into it, and it stays there, and that is, in the case of so small

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a condenser, almost an infinitesimal quantity. Nevertheless, Arnold takes that into consideration as something necessary to establish the potential. He says that no more energy than that trivial amount is required in the grid.

This discussion goes to the concept of what is known as an alternating current resistance of the plate circuit of the tube. In the middle part of column 1, at page 1, he dealt with steady current.

431 He shows how the tube will act as though it had a direct current resistance, and the current will stop increasing just as it would with a resistance, but when you come to the action of the grid to increase and decrease the current, as pointed out, beginning line 59, we have quite another effect. The resistance is not the same. In fact, it is continually changing, but there is here introduced a concept of a variable resistance of the tube, which is a wholly different resistance from this constant resistance which is known as the AC resistance.

432 To make a simple illustration, when a steady state has been established, no signal coming into the grid, we vary the plate voltage a little, there will be a resultant change in plate current. If we deduce from those two things what the resistance of the tube is, we will find it is entirely different from that which we deduce if we take the whole voltage and the whole current. That is alternating current resistance.

By Mr. Ashton:

Q. That is, you have two resistances that you have to think about, the DC resistance and the AC resistance? A. Yes, sir.

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Q. The tube ordinarily conducts current in one direction and that is a resistance which you can speak of as a DC resistance? A. That is correct. When it is carrying the one current which is superposed on the direct current to constitute the signal, then it is quite another resistance.

By the Court:

Q. Perhaps it is not important, but I do not just understand what is the source of the alternating current in this A-41. A. The alternating current comes from the film of light and dark areas on the film. The light shines through and produces an emission of electrons from the sensitive surface of the photo-electric cell which flow through the plate circuit including the resistance K. They develop a variation in the potential difference between the top end of the resistance K and the battery which is supplying the small, feeble current. These variations constitute, in effect, alternating current, superposed on the battery. It is only in the photo-electric cell, just as in the enlarged form, they constitute an alternating current superposed on the direct current furnished by the battery B-1 and the plate circuit on the tube B-1. 434 435

Mr. Ashton: The light shining on the film through the cell, the light actually causing this change of current in the photo-electric cell. As Mr. Waterman explains, when the light hits this potassium or other metal in the cell, electrons are given off and they flow in that circuit, and

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if the light is a little more or a little less, it makes the variations in the circuit correspondingly.

The Witness: The current there in that event is just as in the tube, carried across by the electrons from the surface from which they are emitted to the element which is represented in Exhibit 2 by the circle drawn inside; it is just a little rod inside of the photo-electric cell.

437

By Mr. Ashton:

Q. I believe you stated that this idea of the tube having resistance or impedance was not known before? A. As far as I know, it was a discovery of Arnold's that the tube possessed this property of definite alternating current resistance.

The specification then proceeds to define further terms, continuing at line 75, it says: "Since in this operation the change in power consumed in the output circuit may be much greater than that required in charging the condenser, the device acts as an amplifier."

438 I have already pointed that out in considering the Lowenstein patent.

"This variation in space current, due to an impressed electromotive force, will hereafter be called the output current of the amplifier."

I call your Honor's attention to the specific language; it is this variation in space current which constitutes the alternating current. In other words, an alternating current is superposed upon the direct current, and that alternating current is called output current.

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The patentee then goes on to differentiate precisely what he means. He means the alternating current as distinguished from the direct current would flow whether there was any signal coming in or not. He says at line 86: "The reason for adopting these definitions is that in the practical application of the amplifier it is only these variations in current or voltage which are utilized."

Then he makes a statement which is very excellent proof of the concept that regards the alternating current as superposed on the direct. He says at line 90: "In fact, a transformer is ordinarily used to derive power from the output circuit, and obviously the steady space current or the steady output voltage have no effect in the secondary of that transformer and may be ignored for practical purposes."

It is a perfectly well known fact that if you send direct current through a transformer, you get no effect in the secondary, but when you send the current that comes out of the tube to the transformer, you do, you get variable frequency current in the tube, which corresponds to the socket, showing that it is really an alternating current superposed on the direct current. Then he proceeds to define the term, "voltage amplification." He says: "The term voltage amplification means here the ratio of the alternating voltage appearing in the secondary of such a unity ratio transformer to the alternating voltage impressed upon the filament and grid"—"unity ratio" means primary turns and secondary turns; that is, if you put one volt of alternating current in one end, you get one volt out

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of the other. He defines the voltage amplification in terms of the ratio of the voltage you get out of such a transformer and the voltage that you put in at the grid.

Q. Will you continue with the Arnold Power Circuit patent? A. At line 96 he says:

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"Thus, the term voltage amplification means here the ratio of the alternating voltage appearing in the secondary of such a unity ratio transformer to the alternating voltage impressed across the filament and grid, when the transformer primary is made to include the whole of the output circuit external to the amplifier. In simpler terms, it is the ratio of the above defined output voltage to the impressed input voltage."

444

It may be necessary to explain that the output voltage which is actually realized will depend upon the load that is in the output circuit, and is never the full voltage indicated by the amplification factor of the tube. Thus if the amplification factor is 8, for example, we may realize in the output circuit any part of 8 times the input voltage, depending upon the circuit.

The specification then proceeds to another definition of a quantity which is very much used in dealing with these tubes. Beginning at line 106, he says:

"There will also be occasion to consider the ratio of output current to input voltage, the latter being taken as standard

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throughout. When this ratio is high, other things being the same, the amplifier will be said to be of the high current type, and vice versa. This latter ratio is, of course, not a pure member, but is of the nature of an admittance."

That is to say, it is not the ratio of two like things, therefore it is not a pure number. It is the ratio of an output current to an input voltage. Therefore it is, as he says, "of the nature of an admittance."

Arithmetically speaking an admittance is the reciprocal of an impedance; a conductance is the reciprocal of a resistance. So far as we are concerned the terms "admittance" and "conductance" mean the same thing, and the art uses that term "conductance" rather than the term "admittance." But this admittance which Arnold speaks of is a characteristic and a very important characteristic of the tube, and it is known generally in the art as the mutual conductance.

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Q. The use of that term "mutual conductance" became prevalent after this time, did it? A. Oh, long after, yes. But it has come to be an important factor in the rating of a tube; and, as Arnold states, when that number is large then the tube becomes what the art knows as a power tube, a power type. Arnold says "high current type," which for our purposes is the same thing. He then goes on to point out that it has been found that amplifiers may be designed for given circuit conditions, so that they will have whichever of the abovementioned characteristics is de-

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sired. That is, they may have voltage amplification that we have been considering, or they may have the high mutual admittance or mutual conductance—namely, have a high current output.

He goes on at line 9:

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"That is, one may be designed to deliver to a receiving device a comparatively high voltage with a low current, or vice versa. The principles of operation which have been discovered which enables this result to be accomplished may be stated as follows."

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Then he proceeds to take up the design characteristics of the tubes by which their performance is controlled. He points out that it is desirable in all cases to have the grid close to the filament, that the voltage amplifying characteristic may be given by a relatively wide spacing as shown in Fig. 1 and the high current by a relatively close spacing, as shown in Fig. 2, particularly of the plate with regard to the filament.

Then at line 51 he says:

"A third principle of operation of the thermionic repeater which has been discovered may be stated as follows. To increase voltage amplification decrease the ratio of open space in the grid to conducting surface, and to decrease voltage amplification or to increase the variable output current increase this ratio."

In other words, this filament looking at the grid sees the path between it and the plate largely obstructed by the grid. Then the amplification

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factor of the tube will be high, whereas if the space is widely opened then the amplification factor will be lower but the current that the tube will give, other things being the same, will be greater.

Q. Is this illustrated by comparison of the tubes previously put in evidence, Plaintiffs' Exhibit 12 which is the M-type tube, and Plaintiffs' Exhibit 16, which is the D-type tube and Plaintiffs' Exhibit 18, which is the W-type tube (handing witness)? A. Yes. Exhibit 16 or D-type tube has a comparatively small plate area and a very closely wound grid. In both cases the grid is about as close to the filament as it is safe to put it. The grid is composed of many wires quite close together so that the filament looking through to the plate sees a large obstruction to its passage.

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Mr. Ashton: Can your Honor see the filament in that tube? It is the wires that come down.

The Court: I would say it is a separation of about a sixteenth of an inch or less from the grid.

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The Witness: Yes, it is a little crinkled wire stretched in V-shape in the very center between the elements.

Q. The apex at the top? A. The apex at the top. Exhibit 12 of the M type tube is different. It has a larger plate area; its grid is composed of very few wires, widely spaced. The filament is, as before, an inverted V, mounted centrally of the structure. In each of the tubes the grid covers both sides of the filament. There are two grids parallel to the plane of the filament and

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two plates parallel to the plane of the filament and the grids.

This spacing in the tube of the grid and several of the elements are about the same as in the tube, but the plate is larger in the M type tube. An increase of plate area is equivalent to a closing up of the spacing. In so far as affecting the characteristics of the tube are concerned, the high current type tube having to carry a much higher current, gets hotter in its operation. I have not yet given any reason why it should get hotter, perhaps therefore I ought to point out why it is. Perhaps the easiest way of comprehending the presence of the resistance in the tube is to realize that the plate battery has to accelerate those electrons; the coming off of the electrons from the filament constitute a haze of the filament; they have to be speeded off and across the plate. The energy which each electron carries, therefore, is the same as that carried by any moving body. When the electrons reach the plate, they are traveling at very high speed and that energy or momentum they carry is given off in the form of heat on the plate, with the result that the plate gets quite hot. In the power tubes used in our radio sets, it is not uncommon, if one watches closely, to see that the plates are red hot. That is the result of the bombardment by this swarm of electrons moving from the filament to the plate. That heat has to be gotten rid of, therefore, the plate has to be made of a size that will radiate the heat. Increasing the size, reduces the resistance of the tube. Therefore the M type tube Exhibit 12, is a tube with a lower amplification factor and

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higher current output than is the case with the D type tube 15. The specification continues, line 59, page 2: "The behavior of thermionic repeaters in another very important respect has been discovered. This may be stated as a fourth principle of operation as follows: Maximum efficiency is obtained when the impedance between the anode and cathode is equal to the total impedance of the variable current consumption circuit. This total impedance includes the total line impedance and that of the receiving or translating device or devices to which power is being supplied.

"It has been found that tubes may be constructed in such manner as to take advantage of any number or all of the above mentioned principles with, of course, correspondingly increased efficiency and adaptability.

"An object of this invention is to provide an audion, or an equivalent device, which will amplify the variable energy supplied thereto without at the same time causing a large voltage amplification." 459

That is illustrated by the M type of tube. It does not cause anything like so much, or so large amplification of voltage as in the case of the D type, but it gives larger output of current. Your Honor will recall that the power output is determined by the product of the voltage and the current. Continuing he says: "To provide an audion, or equivalent device, which will cause the amplified energy which appears in the output circuit to take the form of large variable current, rather than smaller variable current with large voltage amplification."

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The W type tube is a large form of the power tube in which the area of the plate required to radiate the heat is very large indeed. The grid will be seen to consist of wires very widely spaced. They are about an inch apart. Your Honor can see the grid structure.

By the Court:

461 Q. The outside metal part is the plate? A. The outside metal part is the plate. There are two plates, one on each side of the central filament, then the grid itself which has wires very coarsely spaced—about an inch apart.

By Mr. Ashton:

462 Q. It goes all the way down? A. Yes. The elements of the tube are crowded as close together as the necessary electrical separation permits, and the tube has very low impedance and capable of giving very large output of current with comparatively small voltage amplification.

By the Court:

Q. These are the plates, that look like shutters? A. Yes, your Honor. The plate is formed by bending strips of material back and forth, that being merely a provision to assist in the evacuation. It is a very difficult matter to get all the gas that is either absorbed or occluded out of the elements, and it is quite common to make the elements in such a manner that they can be treated during the process of exhaustion.

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By making a plate in this manner, it is possible to send the current through it and heat it up and drive the gases out of it.

Mr. Ashton: I offer in evidence section model of copy of the 201-A tube which is used in the first two stages of defendant's amplifiers, that is in the A-41 amplifier, as Plaintiffs' Exhibit 21.

(Marked Plaintiffs' Exhibit No. 21.) 464

Mr. Ashton: And a similar model of the 226 tube which is used in the push-pull circuit of tubes V-4 and V-5 in amplifier A-36, as Plaintiffs' Exhibit 22.

(Marked Plaintiffs' Exhibit No. 22.)

Mr. Ashton: Also similar model of the 250 type tube which is used in defendant's power amplifier as tubes V-6 and V-7, as Plaintiffs' Exhibit 23.

(Marked Plaintiffs' Exhibit No. 23.)

By Mr. Ashton:

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Q. Will you please point out briefly the geometry of these tubes? A. Exhibit 21, which is a unit of the 201-A tube, the exterior globe being broken away, shows the tube as consisting of a central filament of the inverted V type, having a small hook on top, surrounded by a grid of wires rather close together and that, in turn, surrounded by the plate element in the form of a sort of rectangular box with extensions on the sides for support.

The 226 tube which is Exhibit 22 is quite similar in structure, the difference between those

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tubes is mostly that the filament is quite different in its construction in 226 and is of such a low voltage, that it can be used as an alternating current tube, that is, with the alternating current supply, and still have the current go through the cathode element. It is this tube which has the resistance R-4 in defendant's A-36 amplifier for getting the mean potential of the filament and providing bias. This filament, as

467 I recall, takes only about 2 volts, where the filament of 201, Plaintiffs' Exhibit 21, requires 5 volts, and the amount of disturbance introduced by the alternating current on the filament depends quite largely upon the number of volts expended in the filament to set up the electrostatic field of their own inside. Therefore the 226 tube is successfully used as an alternating current tube, that is alternating current heated, whereas the 201-A tube cannot be so used.

Q. Are the tubes of Exhibits 21 and 22 voltage amplification tubes? A. Only as compared 468 with the 250. They are more commonly known as "all apparatus tubes." They have an amplification factor of 8 or thereabouts, but not nearly so high as this D tube, for example. I do not know what the amplification factor of that tube is, but it is evidently of the order of 30 or 40.

By the Court:

Q. You are now referring to what? A. Exhibit 16.

By Mr. Ashton:

Q. Will you now refer to the 250 tube, which is Exhibit 23? A. Exhibit 23 is a power output

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tube and it is characterized in the first place by very large plate area which is necessary, in order to get rid of the heat, due to the electron bombardment. It is next characterized by the grid wires being quite widely spaced. You will find the wires quite widely spaced, so that the filament, which in this instance is in the form of an M, that is, two inverted V's looking at the plate sees a comparatively open space; little interference with the electrons rises and the amplification factor is quite low, of the order of 3-½, while the plate circuit resistance is also quite low. The output current is relatively large indeed. This tube has a mutual conductance, as I recall, of about 2000, whereas the No. 201 has a mutual conductance of about 700.

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Q. What does mutual conductance indicate?
A. High mutual conductance indicates high current type of tube, that is, high capacity,—high power capacity tube.

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Q. Have you completed your references to the specification? A. I have not referred to the balance of the figures. The Figs. 7 to 10 show circuit arrangements. In Fig. 7 there is shown a tube V in which the grid is of fine or close mesh, and the plate widely spaced. This is discussed on page 4 of the specification, beginning at line 61 and extending over to line 123.

The patentee points out that if it is desired to get the maximum output from a tube, then the load applied to it must, in accordance with the principle stated beginning at line 59 on page 2, have an impedance and it should be of the same order as the impedance of the tube and at line 119, page 3, he says: "They should at least be

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of the same order of magnitude, for example, one being 100,000 ohms and the other 25,000 ohms."

He says, "The receiving device 10 may be a second amplifying tube or similar device."

Fig. 8 which is described beginning at line 124, at page 3 shows a tube of the high current type, as indicated by the open grid and closed spacing, and at page 4, line 2, he says: "The impedance of the amplifier between filament and plate is made the same as that of the receiving device 11, or as nearly the same as other operating conditions will permit, and at least of the same order of magnitude."

Fig. 9 also has the same type of tube and differs from Fig. 8 only in detail of the circuit, and perhaps I ought to define that feature. Your Honor will notice in looking at Figs. 7, 8 and 9, that the direct current is not carried through the receiving device itself, but comes from battery B and goes through a choke coil 8 in Figs. 7 and 8 and through resistance 13 in Fig. 9, while the load, the actual working device carrying alternating current is connected through a condenser. This is what is known as the parallel feed method. It is parallel feed as distinguished from Fig. 10, for example, where primary 17 of the transformer carries not only the alternating current, but the direct current, the direct current source being indicated at B¹, a generating machine, in this instance.

The specification points out that the devices 8 and 13 are made of such high impedance that little or none of the alternating current will be shunted. The direct will go through, but the

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alternating current will come out through the receiving device.

Again with respect to Fig. 9, it is pointed out that the high current low voltage amplification type of amplifier is here shown. A tube impedance of the same order as of the telephone receiver 15, being thus obtained. Then it is pointed out that Fig. 10 shows the transformer type of connection and that the tube V¹ is looking into that primary and should be of the same order as primary 17 looking into the tube and if this is of relatively high value, then the tube will be applied accordingly; if it is relatively of low value, the tube will be applied accordingly.

I refer, for instance, to page 4, line 57, as contrasted with page 4, line 39.

This selection of the tube and circuit to have impedance of the same order is a very important factor in determining the effective power amplification of the tube and it is therefore one that is carefully embodied particularly in power stages where the final product which is always power, has to be delivered.

Mr. Ashton: I would like to call your Honor's attention to the fact that this patent contains some claims which are for the tube itself, but that the claims here relied upon are for the combination of the tube with the circuit, and not for the tube itself. In this patent, the claims that we are relying upon are 7, 10 and 13.

The Witness: The subject matter of those claims technically considered is the organization of an output circuit with this

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relation of the impedances of the tube and the circuit of the same order, and it makes,—the invention makes it possible to design output circuits that will operate with large power and at the same time without distortion. It is the use of such circuits that makes possible the large volume of sound that are obtained with present-day amplifiers.

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Q. Now, will you refer to the claims briefly in connection with the defendant's amplifier PA-39? A. Claim 7 refers to the PA-39 in which the 250 tubes are used. Their joint internal AC resistance being 3,800 ohms or 1,900 per tube. Those plate circuits look into a load, which is the two loudspeakers, which pass through the transformer, as seen by the tube, has a load of 5100 ohms, slightly larger than the impedance of the tubes, but of the same order, so that while not the absolute maximum is obtained, it is still near it and very large output power is realized in the circuit. Claim 7 refers to the matching up of the circuits in this manner by construction of the tube, more particularly with respect to the anode and cathode and control element spacing.

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Claim 10 recites the further feature of the mesh of the grid and is otherwise similar.

Claim 13, so far as the technical description is concerned, is rather more general and specifies that the impedance of the discharge device generally cathode and anode and of the work circuit are of the same order. The description of each

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of the claims is illustrated in the PA-39 amplifier.

Q. Will you now refer to the Arnold patent 1,349,252, which is known as the Straight Line Characteristic Patent? A. What is known as the characteristic curve of a tube is obtained by measuring the output current that will flow in an instrument connected between the plate and filament when the voltage applied between the grid and the filament is progressively varied from a considerable positive value progressively down to a considerable negative value. 482

Mr. Ashton: I offer in evidence as Plaintiffs' Exhibit 24 an illustrative characteristic curve of a vacuum tube.

(Marked Plaintiffs' Exhibit No. 24.)

A. (Continued.) If the data so acquired is plotted, the grid potentials being plotted on the horizontal axis and the current values on the vertical axis and then the points so obtained are connected by a line, a curved line somewhat S-shaped is obtained which illustrates the change of plate current with changing grid voltage or potential. This is known as the characteristic curve of the tube. It is nowhere straight. But in order that the amplification which the tube is capable of delivering may be faithful, it should be straight. If it is not straight then the tube introduces into the signal frequencies that were not there originally. These frequencies are second, third, fourth and fifth harmonics chiefly, the second harmonic being the stronger, ordinarily at least. 483

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That means that the tube can only approximate faithfulness of repetition in its own internal operation to the extent permitted by the characteristic. There will be some higher harmonics always introduced. These of course result in a distortion of the signal by the introduction into it of harmonics that are not there originally.

485 This patent 1,349,252 to Arnold discloses the discovery that the characteristic can be straightened by the correct proportioning of the external circuit, and in brief that the characteristic will be made much straighter, approximately straight, if the resistance in the external circuit is made equal to that of the internal circuit or greater. The figures of the patent show the circuit, and in Fig. 1 it is assumed that the load indicated by the transformer not lettered is not such as would produce a straightened characteristic. Fig. 3 shows a resistance added.

486 In other words, the resistance does not have to be in the load, and yet the load will get the straight line effect. In Fig. 5 the resistance is entirely in the load. It is shown as the load resistance across the secondary of the transformer.

Q. Labeled R1? A. Labeled R1. So making the resistance of the output circuit the load as the tube sees it equal to or greater than the internal circuit impedance of the tube straightens the characteristic. The two curves, Fig. 2 and Fig. 4, which show the straightening of the characteristic, are fractions of characteristic curve. The zero line is obviously erroneously located. Tubes never have the maximum curvature on the right side of that zero line. The zero

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line should be about five-eighths of an inch over to the right in each case.

In Exhibit No. 24 your Honor will see the greatest curvature at the lower end is at the left of the zero line, and that should be the case in Figs. 2 and 4. There is obviously a draftsman's error there.

Mr. Ashton: I would like to state, your Honor, that that is the fact, that it is a draftsman's error, as the records of the Bell Laboratories show; and I will probably ask Mr. Darby to stipulate that later.

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The Witness: The way in which this external load impedance acts to straighten the characteristic is a rather difficult thing to explain. I have a sheet containing a number of curves.

Mr. Ashton: I offer the sheet of curves referred to by the witness in evidence, as Plaintiffs' Exhibit No. 25.

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(Marked Plaintiffs' Exhibit No. 25.)

The Witness: In describing the taking of the characteristic of Exhibit No. 24 I said nothing about the plate voltage; I merely assumed that there was a plate voltage. But the particular characteristic curve that is obtained will depend upon just what the plate voltage is for a given tube. If we have quite a small plate voltage the characteristic curve may be such as shown in curve 1 on Plaintiffs' Exhibit No. 25. A larger voltage would produce such a curve as that marked 2.

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And so on, progressively increasing the voltage would produce curves illustrated by 3, 4, 5, 6, 7, 8, 9 and so on. Each one of those separately numbered curves, in other words, illustrates a characteristic of the same tube, but taken with progressively increased plate voltages.

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Your Honor will notice that as the voltage is increased the curves move to the left. The curve 1, for example, is nearly wholly to the right of the zero grid voltage line on this scale on the horizontal line. The curve 9, on the other hand, is nearly wholly to the left. The efficient operation of the tube demands the Lowenstein grid bias, negative bias, and Lowenstein pointed out that as the grid bias was added the plate voltage should be increased, and it is one of the great advantages of the Lowenstein method of operation that it permits the use of the high plate voltage.

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Q. To interrupt you a moment, can you point out on Exhibit No. 24 what happens if a positive bias is used instead of the Lowenstein invention? A. Yes. Looking at Exhibit No. 24, at the left of the zero line it will be observed that there is only one line drawn, namely, the extension of that marked "plate current." On the right, however, another line appears marked "grid current." So as the grid potential is made positive the grid begins to act like a plate, begins to draw current. Some of the electrons go to the grid.

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Q. That is, if the potential is to the right of the vertical line? A. When the potential is positive, that is to the right of the vertical line, some of the electrons go to the grid and a current begins to flow in the grid circuit, which means a current flowing in the whole input circuit of the tube. When, however, the grid is biased negative, then there is no current flowing in the grid circuit of the tube.

This is the efficient way of operating a tube both from the standpoint of the general utility of the tube, and primarily of course from the point of view of freedom from input circuit distortion. We have many kinds of distortion to deal with. The Lowenstein patent has to do with input circuit distortion; this patent 1,349,252 has to do with output circuit distortion, that is, distortion arising in the tube *per se* as a result of its characteristics.

Assuming for the sake of explanation that a tube whose characteristics may be taken as represented by this Exhibit No. 25 is operated with a bias on its grid equal to that denoted by the first scale division to the left of the zero line in the exhibit, a current then will flow which is denoted by the height of the point where a line projected from that scale division would intersect the curve 7. We will say that the curve 7 illustrates the plate voltage that is being used. That current would be read, in other words, on the vertical or plate current scale at the left of Exhibit No. 25, the lower division. That is the static condition of the tube.

Now I will assume that there is in the plate circuit of the tube a resistance equal or greater

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than the internal resistance of the tube; and I will assume that a signal voltage is applied to the grid and that at the instant under consideration that is a positive impulse, and therefore the grid voltage is reduced.

Suppose that the actual magnitude of that voltage is such as to carry the grid voltage toward zero somewhat more than halfway, and that the current then would normally have risen 497 to a point on the curve 7 approximately opposite the number 7. That is what would happen if the tube merely had these measuring instruments across it with which the curve was taken.

But we are now assuming that there is a resistance in the external load which is as large or larger than the internal plate circuit of the tube. That resistance traversed by the increasing current will consume more and more of the B battery voltage. Therefore as soon as that current begins to increase, the tube is no longer working on the curve 7, but it is working on the curve a little to the right, and as that current increases towards the full value that I have assumed it ultimately gets over to a point on the curve 6 intersected by one of the dotted lines not numbered on the diagram. In other words, that is as far as the current can go, because the voltage has now been reduced in the tube to the point where there is a balance.

If the voltage had swung in the other direction the current would have tried to come down on the curve 7 and would have come to quite a low level. But as soon as the current begins to decrease the voltage actually applied to the plate begins to increase, because less is consumed in

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the external load. Therefore the voltage moves up until, for example, it agrees with that of the curve 8. So that when the current finally comes to rest it has come to that value where the dotted curve, which is higher at the right hand end, intersects the curve 8.

If we similarly locate points for widely varying signal voltages we will find that a line drawn through such points is very nearly a straight line. I will call that upper dotted line a, the lower dotted line b. A marked straightening of the characteristic is obtained, and correspondingly a marked reduction in the harmonies introduced into the signal is effected. If the resistance included in the plate circuit had been still higher, the curve would have been still straighter and illustrated, for example, by that marked b.

As a matter of fact there is not much difference in the straightness of those lines. That is due to the difficulty of getting a draftsman to follow points exactly. But it is a fact that the larger the external resistance is made above that equal to the tube resistance, the greater becomes the straightening effect—in other words, the greater the reduction of harmonies introduced into the signal.

This has another very striking effect. Your Honor will notice that if the operation continued on the curve 7, for example, that the signal moving a little over a half inch, say, to the left would strike a portion of the characteristic where the curvature is great. The extent of curvature indicates the extent of introduction of harmonics, and it would very soon reduce the current to zero, because the line 7 rather quickly hits the zero

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axis. But the curve is made by a resistance somewhat greater than the internal plate circuit resistance of the tube has a straight portion extending much further to the left. So that the capacity of the tube to handle signal without distortion is greatly increased. In other words, you not only improve the quality of the output but increase the quantity of output by this relation of circuits—that is, the permissible quantity of input for a given distortion or for a reduced distortion. This can be carried very far by increasing the external resistance.

503 The great advantages of the invention disclosed in this patent 1,349,252 are, then, that it reduces the introduction of harmonics and consequent distortion, and it extends the capacity of the tube. The negative bias is particularly effective with this proportion; for the negative bias requiring and permitting the high plate voltage makes it possible to work on a curve that is moved bodily very far to the left of the zero grid potential point. In other words, the amount of negative bias that can be put on, and therefore the amount of signal that can be put on to the grid of the tube, is increased by increasing the plate voltage.

504 Then when the curved part to the left is straightened out by this co-ordination of Arnold we get a very wide range of operation in the most efficient operating part of the characteristic. And Arnold refers to that, and on page 1, I believe beginning at line 106. I think I have defined the terms of the specification so that your Honor will find no difficulty in following

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it. I will point out what he says at that point.
It reads:

"When these adjustments have been made, operation will take place at an approximately straight part of the characteristic curve and to the left of the current axis in the region of constant input impedance, and at the same time the ratio of amplification is maintained sufficiently high."

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That is the use of a negative bias to give the efficient amplification. I ought perhaps to call your Honor's attention to the fact that in the second column of the specification the patentee points out that when this resistance is included in the circuit the plate voltage must be raised to raise the current back to the same value where it was before.

The patentee points out that when the resistance has been added to the circuit or the resistance of the circuit has been brought up to the amount that he specifies, then in order to get the same amount of current that is found on the characteristic curve when the measuring instrument is put directly across will require a larger plate battery. So the plate battery is here increased by two factors, first the negative bias which requires an increase and, second, the external resistance in the plate circuit which requires an increase. They work together, particularly advantageously, therefore, in throwing the curve to the left and giving a wide range of distortionless operation. And this distortion-

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less operation comes about from the distortionless input obtained by the Lowenstein invention with the distortionless external output effect produced by the Arnold invention.

When I say "distortionless" of course I am not speaking in absolute terms. There is not any such thing as absolutely distortionless, but the tendency is largely in that direction. In the case of Lowenstein it is practically wholly 509 eliminated. That is, what is left is practically altogether negated. In the case of the output circuit one may go as nearly as he pleases to a perfect result, but never attain it.

Q. Will you now refer to Claim 15 of this patent with respect to defendant's amplifiers, all three stages being charged to infringe? A. The technical description which Claim 15 makes goes to the inclusion of an impedance in the plate circuit of the tube such as to cause the output current to vary approximately linearly—that is, according to a straight line—over a portion of the characteristic suitable for efficient 510 operation. That is to say, the portion to the left of the zero grid bias point.

This is illustrated in each one of its amplifiers but not in each stage of its amplifier. In amplifier A-41 it is illustrated in the tube V1. This tube has an internal plate circuit impedance of 11,000 ohms. The arrow on the diagram indicates the direction in which you are looking to find the resistance written just above it. So the primary of the transformer T1 looking at the tube sees a resistance of 11,000 ohms. On the other hand, the tube looking in the direction of the transformer sees a resistance of 60,000. It

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therefore realizes from the tube V1 a very perfect correction of the tendency of the tube to introduce harmonics.

Q. That results in moving the working range to the left of the zero line in the curves to which you have been referring? A. Yes. The tube V3 of the amplifier A-36 has an internal plate circuit impedance of about 10,000 ohms, while the impedance that the tube sees looking into the transformer is about 112,000 ohms. Similarly, the tubes V4, V5 have a joint impedance of about 15,000 ohms, and the tubes look into an impedance of 645,000 ohms. The tubes V6, V7 having an internal plate circuit impedance of 3,800 ohms, look into a load impedance of 5,100 ohms. In all these instances, therefore, the straight line characteristic effect of the patent is realized.

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Q. Will you point out the contrast between the impedances in the amplifier PA-39 and those for example in tubes V4 and V5 of A-36? A. The tubes V4 and V5 are relatively high plate circuit impedance tubes. Their joint impedance is of the order of 15,000 ohms. The tubes V6 and V7 have a joint impedance of 3,800 ohms. The tubes of the A-36 amplifier are what I have referred to as all-purpose tubes. The tubes of the PA-39 amplifier are the high current or as the art knows them power tubes. Take tubes like those of V4 and V5. They are not rated at all, as I recall, in terms of undistorted output, whereas the tubes of the PA-39 amplifier are rated in terms of undistorted current output I think 4,600 milliwatts.

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Q. That is the standard curve sheets for these

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tubes point out in the case of the 250 that it is a power tube giving so many watts of undistorted power output, whereas the curve sheets for the other tubes do not refer to them as power tubes? A. That is correct. The data furnished by the engineering department of the manufacturer gives the 250 under the power amplifier and its u.p.o., or undistorted power output, is given as from 1,600 to 4,600 milliwatts,
515 depending upon the voltage at which the plate is operated. The 226 is not rated on the basis of undistorted output at all; that is, it is not given in undistorted output. The same is true of the 201-A tube.

Q. Will you now refer to Arnold Patent 1,403, 475, the Resistance Capacity Coupling Patent, as to which claims 8, 9 and 10 are relied upon as to defendant's amplifier A-41? A. The circuit arrangement involved in this resistance capacity coupling patent is very simple. I think I have already defined all of the terms that are used in the specification. However, it remains to explain the circuit and some of the differentiations that the patent makes.
516

The drawing shows a two-stage device in which the first stage is a detector and the second stage an amplifier. The two are coupled by a resistance capacity coupling in which the coupling resistance is 25. It carries the current from the battery 26, which flows through the choke 28, the resistance 25, to the plate 21, thence across the space to the filament 8 and back to the negative terminal of the battery. The alternating current in this case, the audio frequency alternating current, flows from the plate across

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the filament; thence through the condenser 24 and through the resistance 25, back to the plate. The flow of this current in the resistance 25 creates a difference of potential between the ends of the resistance 25 corresponding exactly to the signal no matter what the frequency. That is characteristic of a resistance, that the voltage across it is independent of the frequency.

The voltage existing at the top of the resistance 25 is connected to the grid of the tube 31 by a condenser 26, and the negative bias is applied to the grid of tube 31 by a battery 30 whose negative pole is connected to the grid and whose circuit to the filament is completed through a resistance 29.

No current flows in this circuit, but it is necessary to have a connection by which the grid experiences the potential of one end of the battery and the filament the potential of the other end of the battery. This resistance 29 also prevents the interruption of operation of the tube which might occur were the resistance not present due to the accumulation of electrons which might occur, because there would be no way for them to get off, they could not pass through the condenser.

A somewhat similar arrangement, your Honor will note, is found in the grid circuit of the first tube 21, but its function is wholly different in that case. The tuned transformer whose secondary is 19 and which is tuned by the condenser 20, is a radio frequency transformer. The signal is assumed to come in carried on a carrier wave of radio frequency far above any possible audibility. The radio frequency must be gotten

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rid of and the audio frequency signal left. It is the function of that tube 21 to do that, and in that connection we see illustrated another wholly different function of the tube from anything which we have considered, and which I think it is not necessary to go into.

521 The condenser 22 and resistance 23 constitute the particular device employed to make the tube 21 act as a detector, and while they both comprise a condenser and a resistance, the effect is wholly different in this case. The specification distinguishes between the two. As referring to the resistance capacity coupling, I call your Honor's attention to page 1, lines 19 and following, and again to page 1, lines 88 to 102. The first portion of the second column of page 1 is devoted to distinguishing the action that occurs in the condenser 22 and resistance 23. Briefly, I may say that it is a question of what is known as time constant, a technical concept that we do not need to go into except to point out that it calls for different proportion of those devices.

522 Q. What are the advantages of this arrangement? A. The great advantage of the resistance capacity coupling is its entire independence of frequency over a very wide range—the whole range of voice frequencies handled with practically identical efficiency. It also is of great advantage in these days of particularly low-priced radio sets, in its cheapness and also in its compactness in the sets where a lot of amplifier machinery must be gotten in a very small space. It is also particularly adapted to the coupling where the energy is small. For example, in an amplifier for talking motion pictures where the

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signal is taken from a film and converted into current by a light beam in a photo cell, the current that is given off is excessively small. So that to try to do it by transformer or any other means of coupling would be a matter of very great difficulty and accomplished only inefficiently.

Q. Do these remarks have any relation to the defendant's circuit? A. Yes, they are specifically illustrated in the defendant's circuit, where the tube or photo cell which receives the beam of light passing through the film furnishes an exceedingly small current which passes through the resistance K. The difference of potential created in K is passed on to the grid of the tube V1 through the condenser C1, and the bias for the grid is applied through the resistance L. With these factors as given here on Exhibit No. 2 the time constant of that organization is something over three seconds, if I recall, showing that there will be no frequency discrimination over even a wider range than it is possible to use in the transmission of voice and music.

Q. Do the claims in suit 8, 9 and 10 read on this description? A. Yes, they are descriptive of the arrangement. Claims 8 and 9 mention only the resistance K and condenser C1 in Exhibit 2. Claim 10 recites also the resistance corresponding to resistance L.

Q. Will you now refer to Arnold patent 1,448,550, the definite input impedance patent, of which Claims 1 and 12 are relied upon as to defendant's A-41 amplifier. A. The impedance that the input circuit would see looking into an audion may vary over a very wide range. If

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the grid had a positive bias it might be very low. With a negative bias, on the other hand, the input impedance of the tube itself is practically infinite.

From the point of view of minimizing or substantially eliminating the distortions occurring due to flow in the external circuit, the negative grid bias is very perfect. And applied to a telephone line, however, the line looking into the tube will sometimes see a very curious thing. It will think it sees a reflector, and the image will be reflected back in the line. That may produce an echo, so that the speaker at the far end of the line hears his own voice coming back to him a little later. It may serve to upset receiving amplifiers where there is a long line with a succession of amplifiers.

There is another effect. When the transformer secondary which is connected to the tube looks into the tube it sees not only the infinite impedance from a conductive point of view, but it sees the little condenser which is constituted by the grid and the filament.

That taken in conjunction with the inductance of the secondary of the transformer may act like the balance wheel in the hair-spring of a watch.

By the Court:

Q. Would you mind stopping long enough to define "inductance" in plain terms? A. In alternating current circuits, we have two sources of impedance which are different from resistance; the one is known as the reactance of the con-

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denser. The other is known as the reactance of the inductance. When the current flows, there is created a magnetic field; when a potential exists, there is created a static field. Those two fields have their own kick-backs, so to speak, the magnetic field changing through a coil of wire produces an impeded effect and the current flowing in proportion to the intensity of the magnetic field to the number of turns the wire influences. The inductance of the coil, therefore, is the number of turns times the flux change per unit of current flow, or as we say, flux turns per M per M.

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Your Honor can think of it with perfect accuracy by thinking of it as a magnetic field change in each coil due to a change in current and that changed magnetic field produces in the coil an impedance to the flow of current.

Q. Impedance is induced by the magnetic field?
 A. By the magnetic field, yes. That is what we mean by inductance.

Q. Now, just where does that inductance arise in this? A. In the transformer is a large number of turns of wire wound on an iron core, the secondary of that transformer 5 of Patent 1,448,650.

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The Witness: It is the coil to the left side of the figure, but to the right side of the transformer.

The transformer 5 is the input transformer; the right-hand coil of that is the secondary coil. Now, it is possible for that transformer acting with the capacity of the tube to get into a state of oscillation—I mean a state of resonance, I beg your pardon, wherein at a particular frequency the impedances due to the inductance and

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to the tube capacity disappear and the transformer becomes enormously receptive to frequencies of that value, so that it is possible for the resonant effect produced to pick out and exaggerate one frequency. Then there is another difficulty that may arise in any amplifier. It is extremely difficult to so dispose of the parts in all the wires that there shall be no magnetic fields or electrostatic fields reaching over from the output to the input side. If that happens to a sufficient extent, it may set the whole system oscillating like the balance wheel and the hair-spring of a watch. It then becomes a generator, overloads the tube with its own oscillatory current and produces various disastrous effects. If it does not go that far, it may go to the extent of greatly increasing the amplification and of changing the normal frequency characteristic of the transformer. The transformer design in audio frequency amplifiers, is a matter of great difficulty. The transformer tends to work at a particular frequency and all of the powers of an electric designer have to be exercised to get a transformer which will have broad frequency characteristics. The tendency resulting from the feed-back just mentioned, is because the transformer is to be selected for particular frequencies. All of these effects are cured or minimized by putting across the secondary of the input transformer a resistance chosen of proper value to effect the cure of the particular defect experienced.

The tube then looks to the transformer and the incoming line like a definite load of that value selected with a desired end to be attained

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and used and this patent therefore is known as the Definite Impedance Patent.

The specification discusses the varying nature of the input impedance of the tube, and suggests that the resistance 6 may be of the order of 500,000 ohms as a suitable value for most cases, or a range from 100,000 to 1,000,000 ohms.

The resistance serves to prevent reflection by absorbing the energy that might otherwise be reflected. It serves to prevent or minimize the resonance effect by absorbing the energy which would otherwise go into the resonance phenomenon. It prevents or minimizes the effect of feedback from the plate to the input circuit, by again absorbing the energy fed back. 536

Claim 1 of the patent goes particularly, so far as technical description is concerned, to the resistance connected across an inductive input. The transformer is an inductive device; its secondary coil is an inductive coil connected across the input circuit. Resistance is connected across its terminals. That is, in substance, the recitation of claim 1. 537

By Mr. Ashton:

Q. Will you point out the elements corresponding to these in the defendant's circuit? A. It is found in the amplifier A-41 in which resistance of 550,000 ohms connected across a secondary S1 of the transformer T1.

Claim 12 goes to a tube having a practically infinite input impedance, that is, one having a negative bias, and by the way, I should have pointed out that the values, particularly the

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value of 500,000 ohms, which the patentee recites, is with the understanding that the tube has a negative bias.

Claim 12 goes to this combination of a definite input impedance of the order of 500,000 ohms, with a tube having a negative bias, that is, of having an infinite input impedance.

The tube that I just pointed out, S-2, across which the 550,000 ohms is connected, has an infinite input impedance given to it by virtue of the bias derived from the filament current resistance flowing through the resistance R-2.

Q. Will you now refer to Arnold Patent 1,465,-332, the Common Plate Supply Patent, as to which claims 3, 8, 10 and 11 are relied upon as to the A-41 amplifier; and claims 1, 3, 5, 10 and 11 as to the A-36 and P-32 power pact. A. This patent goes to the operation of a plurality of amplifying tubes arranged in tandem or cascade connection on a common battery, that is a common plate circuit battery. In such a tandem amplifier, the signal comes into the first stage, as for instance by the wires, 16, 17, which is amplified by the first tube, as for example the tube 10, passed on in considerably amplified form to the next tube, such as tube 11, and again passed on in further enlarged form to whatever apparatus is connected to the output of the second tube. These all have currents of widely different energy, magnitudes are therefore flowing in the output circuits of these two tubes. The problem is nevertheless to supply them from a common source of space current without their interfering with one another.

Referring to the drawing, battery 20 is shown

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as supplying the space current for both tubes. The positive terminal is connected through a choke coil 21 and through the primary 22 of the transformer with the plate circuit of the tube 10, the current returning from the filament to the minus terminal of the battery 20. Similarly the tube 11 is supplied from the positive terminal of the battery 20 through the coil 28 and coil 29, to the plate 14 of the tube 11 and from its filament returns to the ground connection 30 and thence by way of ground to the ground connection 31, which is at the negative terminal of the battery 20.

Q. You can regard those ground connections as though wires were connected between them?
A. Exactly. That is a mere matter of convenience.

If the two plate circuits were connected directly to the battery without any protecting means, then what would necessarily happen would be that all of that portion of the alternating current of the tube 11 which flows through the coil 29,—and there must be enough to flow through to keep the rest out, otherwise there would be no point in the coil 29,—all of that part flowing through 29, I say, would have to pass through the battery 20; and then by way of ground connections to the filament. But there would be then the plate circuit of the tube 10 also directly crossing the battery and also forming the path for this plate current of tube 11. The result would be that the alternating current from the tube 11 would flow through the plate circuit of the tube 10, and the result of this would be to produce regeneration in the tube 11,

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which might be great enough to set the whole amplifier into a state of oscillation, or as it is called, singing.

Q. Would you please explain the term "regeneration" a little more clearly to the Court?

A. As I have expressed it in other terms heretofore, it implies the passing forward of energy from the output circuit of the tube into its input circuit. All of the energy of the tube 11 which gets into the battery 20 thereby gets into the output circuit of the tube 10; but everything that is in the output circuit of the tube 10 is for the purpose of the amplifier, necessarily made to affect the input circuit of the tube 11. Therefore we would have direct provision for the flow of output current from tube 11 back by way of tube 10 into the input circuit of the tube 11.

It would there be again amplified and again passed back, with the result that there we would get what is known as regenerative amplification, which, as I have already pointed out tends to

546 destroy the effect of the transformer or it might go to the extent of causing the system to oscillate. In order to prevent any such action from reaching large amplitude, Arnold places across the plate circuit of each of the tubes a condenser 23, in the case of tube 10 and 32 in the case of tube 11; alternating current from tube 11 which passes through 29 is given a short, easy path back to the filament through the condenser 32.

Q. Alternating current from tube 11 - A. Alternating current from tube 11 passes through 29 and is given an easy path to the filament through the condenser 32 and does not have to pass through the battery, and the interposition

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of the choke or inductance coil 28 is for the purpose also of imposing a difficulty in the path of the alternating current from flowing in the wire that leads back to battery.

By the Court:

Q. It tends to divert traffic at that point? A. It tends to divert traffic, that is it exactly, yes. He also shows a similar arrangement in the circuit of tube 10. The alternating current of tube 10 is kept out of the battery by 23 and if any of the alternating current from the tube 11 is diverted, for example, due to a cell going bad in the battery 20 and so goes up through the plate circuit of the tube 10, it is first invited to stay in the battery circuit by the impedance imposed by the coil 21 and it is then given an easy path through the condenser 23, so as to side-track it and prevent its going through into the plate circuit of the tube where it really would do damage.

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Those are the means adopted to make practical the operation of the tube from a common source. It is commonly found that the mere use of the condensers is enough, or even one condenser is enough, sometimes just one choke is used, maybe in either of the positions shown; sometimes the whole combination is used, according to the severity of the conditions that are imposed.

Claim 1 goes, technically speaking, to the use of one inductance and one condenser and one tube.

Claim 3 goes broadly to means, whether one

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or more condensers and whether with or without inductance.

Claim 5 goes to one condenser and one inductance, which may be in the same or different circuits.

Claim 8 goes to a condenser across each plate circuit to each tube.

Claim 10 goes to filter connections between tubes, the elements of the filter are not specifically stated. To define that term "filter" I call your Honor's attention to the fact that such a discriminating combination of inductance and capacity or capacity only, or inductance only, is broadly a filter. It tends to separate currents of different frequencies.

Claim 11 is similar in that respect to claim 10.

Q. Will you refer now to the application of this invention in defendant's circuit A-41 amplifier first? A. Referring to the amplifier A-41, each of the plate circuits of the tubes V and V2 is provided with a condenser from the outer end of the transformer primary directly back to the terminal. Thus the condenser C2 is connected to the primary end, of primary P1 and goes directly back to the filament of the tube V1. It thereby affords a short and easy path for the alternating current to flow locally in the tube to transformer and condenser C2. Similarly condenser C3 connected in an identical manner affords an easy local path for the alternating current for the tube V2 and transformer primary P2 and condenser C3, thus minimizing the amount that can get into the B battery.

Q. To which elements in the patent do these

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condensers correspond? A. They correspond to the condensers 23 and 32 of the patent.

In the intermediate amplifier A-36, we have in the plate circuit of the vacuum tube V3 a choke coil G1 with the condenser C4, and choke coil G1 is interposed between the source and feed coil G2, which corresponds to 29 in this patent.

In other words, this is a parallel feed tube just as the tube 11 of the patent is a parallel feed tube, and in coming from the source, we go first through the choke 28 in the patent, then through choke 29. So in this instance, we go through a choke G1 and then through choke G2. The condenser C4 corresponds to condenser 32 and it is tapped off from the plate lead between the two chokes G1 and G2, just as the condenser 32 is tapped off between 28 and 29 in the drawing. The two tubes V4 and V5 are operated in what is known as the push-pull relation, which means that from the point of view of the alternating current, the tubes are in series, so that the alternating current output may be conceived of as flowing from the plate, say, of the tube 4 through the filament system, through the tube V5, through the transformer and back and carried on in the direct current as alternating current superposed. Therefore if the two systems operated ideally, there would be no alternating current flowing from the source at all. Direct current would flow from the source and the middle point of the transformer primary P5 dividing the flow through the tube; the alternating current would be superposed thereon and would, in effect, be purely local. However, such balance

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of the tubes rarely happens. The tubes never perform identically, even though meant to be identical. The result is that some alternating current tends to flow in the direct current lead.

Choke coil G3 is interposed in that lead to minimize any alternating current from flowing in the common supply system which might thereby get back, but this flow is prevented from getting back by the combination of G1 and C4.

557 The condenser corresponding to 32 does not exist in the amplifier but only the choke G3 corresponds to choke 28.

The amplifier PA-39 has only one stage for the source, so the disclosures of the patent do not apply to it.

Q. Will you now refer to the Arnold Patent, the last patent, No. 1,520,994, "Gain Control Patent," of which claims 1 and 4 are relied upon as to the A-41 amplifier. A. This patent goes to the control of the amplification of an amplifier without changing the impedance that

558 the amplifier presents to the line and without altering the operating characteristics of the tube or its relation to its circuits. All these things are important factors in the determination of the freedom from distortion that this type of amplifier has. What the patent shows is a means of controlling the gain without influencing any of these factors, which consists simply in the use of a potentiometer 25, whose variable connection 26 is connected through the biasing battery to the grid and filament elements of the following tube.

A potentiometer is, in the sense in which I use it, and its usual significance is a resistance pro-

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vided with means for making connections to its ends and also to the variable points between the ends. It is commonly known also as a voltage divider.

Resistance 25 is connected across the secondary 24 of the intermediate transformer, and the patent states that between stages in that area is a very advantageous place to put the gain control.

The grid 13 of the tube 11 is connected to the movable contact 26 which may be adjusted anywhere along the resistance. I have explained to your Honor that whenever the source of voltage is connected across an external load device the entire voltage of the transformer will be, or the source will be dissipated somewhere or other in that load, so the entire alternating power voltage of the secondary transformer 24 is distributed along that resistance 25, therefore, by moving the point 26, any part of it may be taken off, because the filament connection is fastened to the bottom, therefore, if point 26 were to be at the bottom end, then no voltage at all would be taken to the grid and we would have no output. If we moved it to the top, then we would have maximum output. Any output between can be attained. At the same time, the circuit constants are maintained entirely as desired by the selection of the original value of the resistance 25. In other words, it becomes the definite input of the patent and similarly any alteration that is made in the relation between the output impedance of the tube and its internal impedance and therefore neither the energy relation established by the designer or

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the straight line characteristic relation established by the designer is altered by that mode of control or gain. The specification points out at page 1, line 90, that a negative bias is necessary for the application of this method of grid voltage control, as otherwise the variable impedance of the input circuit of the tube would alter the impedance of the combination of potentiometer and tube as seen from the transformer secondary.

563 The specification points out in the second column on page 1, various advantages, as for example, it permits the interchange of tubes. No, that is another patent I am thinking of. No, that is not pointed out, but it is true nevertheless, it permits the interchange of tubes without affecting the character of the amplification.

Q. Is the invention defined in the two claims relied upon, 1 and 4? A. Yes. Claim 1 goes to the combination of the input circuit with impedance in shunt, as for example, impedance D in the secondary transformer T1 of amplifier A-41 and means comprising a contact movable along said impedance for effectively controlling electrode B1 with any desired potential point on the resistance D1 that is being affected by the contact Q1.

Q. The reference to "shunt" means connected across the input circuit? A. Yes.

Q. Does claim 4 bring in negative bias? A. Yes, claim 4 brings in negative bias in addition to the element specified in claim 1.

Q. I direct your attention again to the Arnold Straight Line Characteristic Patent 1,349,252, and ask you if you have any authority to which

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you would wish to refer as to the invention of this patent? A. I have in mind the work entitled, "Thermionic Vacuum Tube," by Van Der Bijl, which has been the standard authority on vacuum tubes since its publication in 1920. On page 170 of this book, after treating the subject mathematically, the author says:

"This is the equation for the characteristic of the circuit consisting of the tube and resistance r_o , and it will be seen, if I_p be plotted against $E^1 r$, for various values of r_o , that the curvature of the characteristic is reduced as r_o is increased, the characteristic becoming practically linear when r_o is equal to or greater than the plate resistance. This is an important result for which I am indebted to my associate Dr. H. D. Arnold, and has an important bearing on the problem of distortionless amplification of telephonic currents."

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Q. Is Van Der Bijl referring to Dr. Arnold, the patentee of this patent in suit? A. Yes.

Q. Do you have any other person in mind who has referred to the advantages of this Straight Line Characteristic Patent? A. Dr. Lee De Forest, the inventor of the three electrode audion, in one of his articles published in the journal of the Franklin Institute for July, 1920, at page 10 of the article, the top of the page, says:

"Consequently we find telephone engineers going to extreme lengths to so

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design their audions and circuits, and to so regulate the potentials applied to the grid, as to operate entirely within this straight line characteristic. The result is a perfect reproduction of voice currents, but magnified to any extent desired by the use of two or more such amplifiers connected in cascade—from ten to twenty thousand times or more."

569 Q. Does Dr. De Forest also refer to power tubes which were an element in the claims of the Patent 1,329,283, the Power Circuit Patent? A. Yes, he refers to the 1915 tests of the Western Electric Company on page 21, where he says after referring to preceding work:

"Such rapid progress was made in improvement of design and construction of these so-called 'power tubes,' notably by the engineers of the Western Electric Co., that by autumn of 1915 a bank of several hundred tubes, their input and output electrodes connected in parallel, were installed at the Arlington wireless station."

570 Q. Does he also refer to the invention of the Lowenstein patent on page 28? A. He refers a number of times to the use of the Lowenstein invention.

Q. I direct your attention to the first paragraph. A. The first complete paragraph on page 28 says:

"The audion which has been evolved to meet these requirements, most rigorous of all its numerous applications, differs in

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many details from the detector or the oscillating audion. The presence here of gas ionization sufficient to cause appreciable distortion cannot be tolerated, neither must the grid be permitted to be positive at any phase of the cycle of impressed voltage. A hundred other minor requirements, small yet difficult of realization, have been patiently achieved by our telephone engineers, who now state that 'the amount by which it (the audion amplifier) fails to meet all the requirements for a perfect repeater is so small as to be negligible except under the most rigorous conditions.' "

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Q. Does Dr. De Forest also refer on page 25 to the audio amplifier and repeater work of the Western Electric Company? A. Yes, after discussing the various circuits he says, at the bottom of page 25:

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"The development by the engineering staff of the Western Electric Company of the audion amplifier as a telephone repeater since my first demonstration to them of its possibilities in that field, are beyond all praise. The zeal and rare understanding of the elements of the problem with which this staff of trained men developed the amplifier and applied it to the long-sought transcontinental telephone line stand unique in the annals of brilliant achievement in electrical engineering."

Mr. Ashton: I offer in evidence a copy of Dr. DeForest's paper from the journal

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of the Franklin Institute, Volume 190, July, 1920, No. 1.

Mr. Darby: I object to its receipt in evidence, because everything that is apparently pertinent has been read into the record already. It just encumbers the record.

Mr. Darby: If you agree to treat it as a physical exhibit, I shall withdraw my objection.

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The Court: That is very nice, thank you.

Mr. Darby: I would like to record on the record my objection as to its materiality.

The Court: I think it probably goes to the weight.

Mr. Darby: Yes, your Honor.

The Court: Objection overruled and exception.

(Marked Plaintiffs' Exhibit No. 26.)

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By Mr. Ashton:

Q. Will you state some of the uses to which the various types of vacuum tubes contained in the defendant's amplifier have been and are being put? A. Substantially the uses that I have mentioned for the amplifiers. I do not know that this particular number of tubes are used in wire telephony, but tubes of similar characteristics are employed, and of course, there are other fields, also tubes of similar characteristics are employed, particularly the power type tubes, which are used in railroad signaling and in au-

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tomatic train control where they have a considerable field and for various laboratory purposes their uses are extending all the time.

Q. Do you have in mind 201-A, 227, 226, 250 and also the 280 and 281 tubes? A. Yes, except that I do not want to be understood as saying of my own knowledge that those particular tubes are used in wire telegraphy or wire telephony, but tubes of analogous character are.

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Cross Examination by Mr. Darby:

Q. How long have you been familiar with the use of those respective tubes of analogous character? Over a considerable period of years? A. Oh, yes.

Q. They have been readily available in the open market, have they not? A. For a good while, yes.

Q. In other words, there are retail stores scattered throughout the United States in which tubes of those characteristics can be purchased across the counter? A. There are and have been for some time, yes.

Q. You made reference to an authority of Dr. Van Der Bijl; I did not hear you give the date of publication of that book. A. It was 1920.

Q. Who is Dr. Van Der Bijl? A. He was a research engineer in the Bell Telephone Laboratories, I believe. He has not been associated with them, if I am correct, on my information, for a great many years, and I don't know what his connection is now.

Q. You know that he was associated with the Bell Telephone Laboratories at the time he wrote

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the book, do you not? A. Yes, at the time the first edition came out, he was.

Q. Now, with reference to the defendant's apparatus, that apparatus, just as it is shown there, has an amplifier that can be used for any one of a number of purposes, that you mentioned, namely, in connection with wireless telephony, wire telephony, public audition systems or sound systems in connection with motion pictures, can it not? A. Well, I don't know that that is quite so. There are three units there, and, of course, various other units are made, and those are selected, the particular units to be used, are selected for the particular purpose that one has in mind. Broadly speaking, I should think that the proposition may be assented to. However, probably it might not be chosen for all those purposes.

Q. You have all the dimensions given there; is there any reason that you can advance why that particular instrumentality could not be used as an amplifier in connection with radio work? A. Well, certainly not without slight alteration, but it could be adapted to radio work.

Q. Are you familiar with the particular apparatus of which that wiring diagram was taken? A. No, I have not used that particular apparatus. I am familiar with apparatus of that kind.

Q. Have you seen that particular apparatus? A. No, I have not seen that particular apparatus.

Q. Then, you do not know of your own knowledge whether that particular apparatus is sold for use in connection with radio broadcast reception? A. Why, the units undoubtedly may have been. I have no intention of saying that the

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units could not be used in radio. I merely mean that the organization has to be adapted to radio.

Q. What change in adaptation would be necessary? A. Well, at least suitably to change the input circuit.

Q. By that you mean to eliminate the photo-electric cell? A. Yes, and make suitable coupling and suitable radio circuit.

Q. Do you see any other changes of adaptation that would be required other than perhaps connecting to a loudspeaker or something of that kind? A. I think the units could be adapted to the circuit. I do not think anyone would use it just as it stands.

Q. I see. Can you give me a brief workable definition of "impedance"? A. Well, yes. It perhaps depends on what you have in mind. Impedance is that which impedes the flow of alternating current.

Q. And can you enumerate the types of impedance that are ordinarily used in vacuum tube circuits for that purpose? A. The reactance of inductances of various types. The reactance of condensers and resistances.

Q. As a matter of fact, every wire has a certain amount of resistance, has it not? A. Certainly, yes.

Q. And to the extent that any conducting wire has that amount of resistance, that wire imposes an impedance equal to the resistance of the wire, is that right? A. Yes, certainly.

Q. Now, in determining the internal impedance of a vacuum tube, will you please enumerate the factors that control that? A. You mean the factors that control the method of measurement?

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Q. No, the factors which control the make-up of impedance. A. Well, answering your question as broadly as you stated it, one would have to say all the factors that go to the operation of the tube.

Q. And they are what? A. Temperature of the filament, the nature of the grid, the nature of whatever sources are connected to it, structure of the plate, the space relations of all of the elements, voltage supplied to the plate.

587 Of course, the nature and quantity of emission of electrons from the filament. I do not mean by that to say that there are electrons of two natures, I mean the nature of the filament and the quantity of emission from it.

Q. When you say the nature of the grid, by that do you mean the size of the wire constituting the grid or do you mean to include that?

A. The size of the wire and space of the wire.

Q. You mean spacing between the various turns in it? A. Yes.

588 Q. When you say the structure of the plate electrode, you mean to include the thickness of the plate? A. No, the thickness is not an element. It is the area and its spacing which are the two essentials.

Q. Is one of the factors the spacing between the grid electrode and the plate electrode? A. Yes, although that is more concerned with the amplification factor than it is with the internal impedance. It is more particularly the distance between the filament and the plate that is of prime importance in determining the internal resistance.

Q. Is the spacing between the grid electrode

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and the filament electrode one of the factors? A. So far as I know, that does not enter into the plate circuit resistance, if the spacing of the plate and filament are not thereby altered. I am not sure about that, Mr. Darby.

Q. Finally on that subject, is the degree of evacuation of the tube one of the factors? A. Yes, if the evacuation is low enough so that the working velocities of electrons are sufficient to produce gaseous ions to a notable extent, then the resistance is enormously affected.

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Q. Can you tell me, in radio circuits or vacuum tube circuits, what is considered to be meant by the term "high resistance"? In other words, where is the dividing line between high resistance and low resistance? A. Well, the so-called high mutuals I think might be classed as having internal plate circuit resistance of the order of, oh, 50,000 ohms up to several hundred thousand. The all-purpose tubes run around 8900 to 12,000, and the power tubes, I think the smallest of them go as high as 4000 or 5000 ohms. The more generally used tubes are 2000 ohms or less.

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Q. Which of those would you call high? A. Those that I mentioned first, I would call high; the next ones are intermediate and the power tubes are ordinarily considered as low resistance tubes.

Q. The ohm, of course, is the unit of resistance? A. Yes, sir.

Q. How many ohms equal a megohm? A. One million.

Q. What is meant in this art by the expression "attenuation"? A. It refers to a weakening of

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the signal applied particularly to long lines where distributing inductance and capacity enter. I could illustrate that by a statement that used to be quite frequently made, that is, if you have a line reaching from New York to San Francisco, you could not put power enough in the New York end to get a message through to San Francisco, because of the attenuation of the cable.

593 Q. Is attenuation one source of distortion? A. Yes, that is partly what Lowenstein has in mind in the first column of the page 1 of the patent.

Q. Now, referring again for the moment to the matter of the spacing between the grid electrode and the filament electrode, has the distance of the grid from the filament any important bearing on the function of the tube for the purpose of obtaining voltage amplification? A. The theoretical formulae, as I recall them show that it has an effect, but is less important than the space between the grid and the plate.

594 Q. On the question of distortion, how many kinds of distortion are there? I am informed there are three kinds, namely, frequency distortion, harmonic distortion and phase distortion; do you agree with me on that? A. That is one way of classifying them, yes.

Q. Those three kinds of distortion— A. There may also be intensity distortion.

Q. Intensity distortion? Now, in connection with vacuum tube amplifier, an illustration of the frequency distortion, is where the vacuum tube will amplify one or more frequencies of a class greater or less than it amplifies one or more

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frequencies of a different value, is that right?

A. Yes.

Q. Now, can you give me a similar brief illustration of the harmonic distortion with the vacuum tube amplifier? A. Well, I take your expression to mean that the tube may introduce frequencies which were not contained in the signal originally, in view of its own operating characteristics, and so produce frequency distortion.

Q. That is right. Did you intend that as an answer to my last question? A. Yes, isn't it?

Q. On the harmonics? A. The tube introduces harmonics. In view of the nature of this characteristic, it may impose second, third, fourth or even fifth harmonics on the signal.

Q. I do not know whether the Court has clearly in mind what is meant by "harmonic." Can you give a simple definition or illustration of it? A. I meant by using the term harmonics, multiples of the fundamental frequency.

Q. Can you give me an equally simple illustration of phase distortion? A. I do not know that phase distortion occurs in the tube itself. It is rather the result of the whole organization. The various component frequencies that go to make up sound are related in three ways. First, as to their relative frequencies, second as to their relative intensities and third as to their relative phase. The phase distortions that I assume you are referring to, are more commonly the result of the circuit. They necessarily enter in it somewhat where the tube introduces harmonics.

Q. You added to my original three, the intensity distortion. Can you give me a simple il-

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lustration of that? A. It sometimes happens that phase distortion of tube and circuit will amplify feeble signal more than a signal of greater intensity, therefore, the relative proportions of the components, both instantaneously and with time, may not be preserved.

Q. You referred a moment ago, in cross examination, to formulae with which you were familiar in connection with the subject of voltage amplification and the spacing of the grid from the filament. I show you a formula in Professor Morecroft's book entitled, "Principles of Radio Communication," page 384, and ask you if that is the formula you have referred to?

Mr. Ashton: What is the date of the book, Mr. Darby?

Mr. Darby: I don't know. Will you give us the date, please?

The Witness: Copyrighted 1921. No, that is not the formula I had in mind, and the distance between the grid and filament does not appear in it at all.

The Court: What is that book?

Mr. Darby: Professor Morecroft's book "Principles of Radio Communication."

Q. Now, will you please refer to Plaintiffs' Exhibit 2, defendant's apparatus and taking up first the amplifier A-41, will you please state whether the exterior circuit connected to the grid and filament elements of the tube V1 has a greater or lesser impedance than the external circuit connected to the plate and filament electrodes of that tube? A. I did not get the first part of that. Will you please read the question?

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(Question read.)

A. A greater impedance.

Q. Now, with respect to the tube V2, has the external connection between the grid and filament a greater or lesser impedance than the internal connection between the plate and filament of that tube? A. Greater.

Q. Going to the intermediate amplifier A-36, will you answer the same question with respect to the input circuit of the tube V3? A. Greater.

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Q. That is, the input circuit has greater impedance than the output circuit, is that right? A. As I understand it, yes, sir.

Q. Now, with respect to the tubes V4 and V5, will you answer the same question? A. The input circuit has the smaller impedance, as I understand it.

Q. Will you answer the same question with respect to the tube V6? A. The input circuit has greater impedance.

Q. Now, will you please refer to the patents in suit, in each instance in defendant's apparatus where the negative bias is employed, the particular means for effecting the negative bias is not the means illustrated in the drawing of the Lowenstein patent, that is correct, isn't it? A. It is.

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Q. Now, if you will refer to the Mathes patent. In the illustration of the Mathes invention the negative bias on the grid is obtained from the source of current utilized to heat the filament; is that correct? A. In Figs. 1 and 2; that is right.

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Q. How about Figs. 3 and 4? A. It is not obtained from the filament current in that instance.

Q. What is the source of negative bias on the grid in Figs. 3 and 4? A. The battery 7 sends a current through the resistance 9, and the drop in that resistance is the source of the bias.

Q. And in each of the figures the negative bias imposed upon the grid of the tube is effected by a resistance that is connected in series circuit connection with the filament; is that right? A. No, not if you mean in the heating circuit of the filament.

Q. That is true with respect to Figs. 1 and 2, is it not? A. Yes.

Q. Now, with respect to Figs. 3 and 4, I understood you to say that the drop in potential across the resistance is what impressed the negative bias on the grid? A. That is correct.

Q. Which resistance are you talking about? A. The resistance 9. That resistance is not in the filament heating circuit.

Q. That is, however, in the connection between the grid and the filament? A. Yes.

Q. If you will refer to Arnold Patent 1,329,283, which has been described as the power circuit patent. Whether or not one utilizes what is selected as the invention of this patent depends upon the internal impedance of the vacuum tube employed; is that not correct? A. I question very much whether you could accurately express it that way. It is rather the organization of the whole circuit, such that the tube resistance and the circuit resistance are of the same order.

Q. And if the impedance of the output circuit

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is of a certain value, then the impedance, internal impedance of the tube, would be of the same order; is that right? A. If the organization corresponded to the disclosure of the patent as referred to in the particular claims in issue, yes.

Q. Therefore, in determining whether or not the claim combination or combinations of the claims in issue were being utilized by any particular instrumentality it would be necessary for you to know the external impedance in the output circuit of the tube as well as the internal impedance of the tube; is that right? A. Yes.

Q. Will you please refer to Arnold Patent No. 1,349,252, which has been described as the Straight Line Characteristic Patent. The instrumentality which has been selected to illustrate the asserted invention of this patent is a resistance connected in the plate circuit of the vacuum tube; is that right? A. I think that is hardly clear. I pointed out that in Fig. 3 a resistance has been inserted in addition to the indicated useful load circuit, whereas in Fig. 5 the resistance itself is in the useful load.

Q. And the patentee's description of Fig. 5 is contained on page 2, lines 5 to 24; is that correct? A. Yes.

Q. And the patentee states that his invention can be utilized by carrying into the output circuit the effect of a resistance contained in a coupled circuit; is that correct in substance? A. Yes.

Q. So that the means selected by the patentee to illustrate his invention is the utilization of a resistance either connected in the output circuit or imparted to the output circuit from an outside

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source by suitable coupling; will you accept that statement? A. Yes, I think that is a fair statement, provided that it is not in conflict with what I said before, namely, in Fig. 5 of the resistance R is the load or perhaps it is R^1 that is the load, and it is whatever resistance the load itself imposes.

Q. In other words, the point that you are making is that there must be something more than merely the resistance itself; is that right? A. Yes.

Q. The resistance must be added to its normal load? A. No, in Fig. 3 he shows a resistance added; in Fig. 5 the resistance is the load. That is whatever load is there as the resistance.

Q. Turn to Arnold Patent No. 1,403,475, which has been characterized as the Resistance-Capacity Coupling Patent. What there is in this patent illustrated to show the asserted invention—that is, as defined in Claims 8, 9 and 10—is a resistance connected between the plate and filament circuit of one tube and a direct connection through a capacity or condenser to the grid of the succeeding tube; is that right? A. Those are the elements referred to in Claims 8 and 9. Claim 10 also refers to the resistance 29 through which the biasing connection is made.

Q. Now if you will refer to the Arnold Patent No. 1,448,550, given the name Definite Input Impedance Patent. What has been utilized by the patentee to here illustrate his invention is an impedance connected in shunt across the input transformer of a vacuum tube amplifier; is that right? A. Yes.

Q. Now in calculating impedance of a circuit

Frank N. Waterman—For Plaintiffs—Recalled— 613
Cross.

you include the values of the condensers and the inductance coils and the resistance, the choke coils, in that circuit, do you not? A. If that is what you want to know.

Q. If you want to know the impedance? A. The total impedance, yes.

Q. A question by the Court induces me to go back and retrace my steps a bit, Mr. Waterman, if you do not mind. Arnold's Patent 1,329,283. Referring to Fig. 7 of the patent, for example, would the resistance 6 connected across the input line be taken into consideration as an impedance if you were calculating the input impedance? A. Yes, if you are calculating the impedance that the tube looks into you would include the resistance.

Q. The output circuit includes the condenser 9 and the choke coil 8 and the receiving device 10. In determining the impedance of the output circuit each one of those elements would play its part in determining the impedance, would it not? A. Yes, you calculate the impedance of the network. That is stated at the top of the second column, page 2.

Q. Maybe we can dispose of it with this general question. If you are going to determine the true impedance of an output circuit you determine the impedance of every instrumentality that is in that circuit, do you not? A. Yes.

Q. Taking this next Arnold patent, which is 1,349,252, the Straight Line Characteristic, the resistance element which the patentee uses to illustrate the application of his invention, is the resistance marked R in Fig. 3 and the resistance marked R¹ in Fig. 5; is that right? A. Well, I

616. *Frank N. Waterman—For Plaintiffs—Recalled—
Cross.*

am not quite sure that it is. As I understand it in Fig. 3 R is the resistance illustrating a way of bringing the resistance of the output circuit up to a value equal to the internal resistance of the tube or greater. Of course it would be the same thing if it were in the load. Now in Fig. 5 it is the entire load.

617 Q. Then it is your understanding that what Arnold is doing in this patent is to bring the total impedance of the output circuit to a point where it is equal to or greater than the internal impedance of the tube; is that right? A. Yes.

Q. And in Fig. 3 he adds a resistance to the output circuit for that purpose, and that resistance is R? A. Yes.

Q. And in Fig. 5 he has a load or if necessary adds a resistance R' of the desired amount, to bring it up to the internal impedance of the tube; is that right? A. Either could be done. He shows the first.

618 Q. Going again to Arnold Patent 1,403,475, the Resistance Capacity Coupling Patent, the instrumentalities that we reviewed just a minute ago, utilized by the patentee to illustrate his asserted invention as defined in Claims 8 and 9, are the resistance 25 and the condenser 26; is that right? A. Yes.

Q. And the instrumentalities utilized by the patentee to illustrate the invention as defined in Claim 10 consist of the resistance 25, the capacity or condenser 26 and the resistance 29; is that right? A. Yes.

Q. If you will please turn to the Arnold Patent 1,465,332, which has been called the Common Plate Supply Patent. The common current sup-

Frank N. Waterman—For Plaintiffs—Recalled— 619
Cross.

plied for the plate electrodes of both of the tubes shown is the battery 20; is that right? A. It is.

Q. And the series inductance as used in the claims of that patent in suit comprise the inductance coils 21 and 28; is that right? A. Yes, each of those is a series inductance.

Q. And the bridging capacity referred to in the claims in suit is illustrated by the condensers 23 and 32; is that right? A. Yes, each of them is such a condenser.

Q. Now if you will finally turn to Arnold Patent No. 1,520,994, which has been characterized as the Gain Control Patent, the instrumentality which has been selected by the patentee to illustrate the invention asserted by the claims of this patent in suit and defining those claims as an impedance connected in shunt to the source of current is the resistance 25; is that right? A. It is.

Q. And the feature of adjustability of that impedance which is referred to in the claims of the patent in suit is illustrated by the arrow point 26 which is schematically illustrated as adjustable; is that right? A. I think not. Not if you meant literally what you said. The impedance *per se* is not adjustable. What is adjustable is the portion of the voltage drop across it which is taken to the grid.

Q. And that adjustability is obtained by means of the arrow point 26? A. That is correct.

Q. In one of these claims in suit the impedance thus connected is referred to as a potentiometer. That is merely a technical name for the arrangement shown by the resistance 25 and the tap connection 26, is it not? A. Yes.

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622 Frank N. Waterman—For Plaintiffs—Recalled—
Re-direct.

Re-direct Examination by Mr. Ashton:

Q. Listening to Mr. Darby's cross-examination I notice particularly he was referring to particular elements of these circuits. I rather gathered that he was trying to give the impression that the resistance here and there was all there was to it. In your direct testimony you have described the other elements, have you not, that enter into the 623 combinations of these claims? A. Yes, certainly.

Q. And pointed out the modes of operation? And the effects which the elements of the circuits as a whole have upon the result to be obtained? A. No. Certainly those elements have got to be taken with the whole combination. In most cases I think Mr. Darby merely identified elements which were distinctive without intending to include the whole combination. I answered with the understanding that he meant they were in the whole combination.

624 The Witness: The Lowenstein patent, as I understand its disclosure, goes generally to the operation of a tube with a source of potential applied between the filament and the grid, to render the grid definitely ultranegative with respect to any part of the filament. On this ultra-negative potential the signal is imposed. The claims recite the complete combinations that constitute the invention, as I understand them. The Mathes patent carries forward the same idea, but goes to particular ways of getting that negative bias that are convenient and have other advantages. So far as Claim 8 is concerned the technical description of that claim is illustrated in Figs. 1 and 2 and Mathes gets the same nega-

Frank N. Waterman—For Plaintiffs—Recalled— 625
Re-direct.

tive bias and for the same purpose, but he gets it by means of a current flowing through a resistance, which current in Figs. 1 and 2 is the heating current for the filament. And he points out that that is a convenient method, in that it does not require an extra battery, and it is a useful method in addition, because the bias which is then acquired is one which will vary with the filament current and where the batteries are arranged as he shows, also with the plate voltage. 626 Therefore offering compensation for disturbance that would occur if those voltages did not vary together. Also he points out that that compensation may not be exact, but it is in the right direction, and it can be made more exact by an appropriate determination of the particular character of that resistance. That is found at the bottom of column 2 of page 1 and at the bottom of column 1 of page 2.

Mr. Ashton: I offer as a physical exhibit, and for the purpose of showing what was before the Court as to the Lowenstein patent in suit, on the merits, and as to the so-called vacuum tube license defense, the record in the Court of Appeals for the Second Circuit in the case of Western Electric *et al.*, vs. Wallerstein.

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Mr. Darby: I object to its receipt in evidence. I have no objection in the world to the Court having it, or presenting it to the Court informally for that purpose. I want to correct an impression Mr. Ashton is laboring under, and I do not want your Honor to get a wrong impression from that

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source. The Wallerstein case was entirely different from this case.

The Court: Why do you need it as a physical exhibit, Mr. Ashton?

Mr. Ashton: We want to know what was before the Court. In order properly to refer to what was before the Court in that case we should have the record identified as a physical exhibit. That is frequently done, your Honor, and in the Wallerstein case the second exhibit which I was about to offer was handled exactly that way—namely, the record in the Bunnell case, which I was going to refer to next, in which the Lowenstein patent and also the Mathes patent Claim 8 here in suit were sustained.

The Court: Of course any practical difficulty in making up your record will be obviated.

Mr. Darby: If it is a physical exhibit?

The Court: Yes.

630

Mr. Darby: I do not think it is admissible, but I say to your Honor, I want you to have it anyway.

The Court: You want me to have it but you object to it being received in evidence. Objection overruled, with exception.

Mr. Darby: Of course we are not bound by any testimony in the case. Its use is limited to that purpose, I assume.

The Court: I did not mean to anticipate argument with respect to the weight of the evidence.

Mr. Ashton: I want it clear that it is offered only as to what was before the

Court on the merits of the Lowenstein patent, and on the so-called vacuum tube license defense.

(Marked Plaintiffs' Exhibit No. 27.)

Mr. Ashton: I also offer in evidence the record in the case of Radio Corporation of America, *et al.*, vs. J. H. Munnell & Company, *et al.*, in the Southern District of New York, which involved the Lowenstein patent herein suit and also Claim 8 of the Mathes patent, for the purpose of showing what was before the Court in that case.

The Court: That is Judge Winslow's case?

Mr. Ashton: Yes.

Mr. Darby: To be consistent, I make exactly the same objection; but I add to it a practical objection now. That case never went to the Court of Appeals, and I have not any means whatever, while it is purged in typewritten form—

Mr. Ashton: Let me state this record was handled in exactly the same way as the Lowenstein case, and we loaned it freely to Mr. Davis's office, back and forth, and you would be at liberty to do the same thing at any time.

The Court: To be consistent I will make the same ruling.

(Marked Plaintiffs' Exhibit No. 28.)

Mr. Ashton: That closes the plaintiffs' *prima facie* case.

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DEFENDANT'S PROOFS.

635

Mr. Darby: To establish the chain of title and the authority for the American Transformer Company to manufacture the equipment that it made and sold to us under the patents in suit, as we contend, it is necessary for me to go to Governmental documents. The only form in which I have them is in the report of the Federal Trade Commission on the radio industry, which contained these documents, and I do not want to encumber the record with the entire report of the radio industry, so I would like to offer in evidence the particular agreements that I desire to utilize, with leave to substitute those agreements after I can have them copied. I know that the plaintiffs have many copies of them and maybe they will be kind enough to let me have copies of them.

636

Mr. Ashton: Can't you tell me what agreements they are and offer them later?

Mr. Darby: Surely. I tell you now it is the license agreement of the General Electric Company and the Radio Corporation of America dated the 20th day of November, 1919. That is the first one. The second one is the agreement of the General Electric Company and American Telephone & Telegraph Company dated July 1, 1920. The third one is called the extension agreement, General Electric Company, American Telephone and Telegraph Company, Radio Corporation of America and Western Electric Company. Just those

three. It shows the arrangement between the General Electric Company and the Radio Corporation of America and then between the General Electric Company, A. T. & T., and then between all of them and the Radio Corporation of America.

Mr. Ashton: Will you please repeat the purpose of the offer?

Mr. Darby: I want to prove the chain of license under the patents in suit to the American Transformer Company, of the apparatus they sold to us.

Mr. Ashton: And that is the only purpose?

Mr. Darby: Yes.

Mr. Ashton: No objection.

Mr. Darby: Mr. Ashton has referred to another agreement and I would be glad to offer it. I picked out the only ones I thought were applicable. It is entirely agreeable, I understand, to Mr. Ashton, that we furnish clean copies of these various agreements.

The Court: We will reserve the first four letters of the alphabet for these exhibits.

(Same to be marked Defendant's Exhibits A, B, C and D.)

Mr. Darby: I offer in evidence a conformed copy of the license agreement between Radio Corporation of America, General Electric Company and Westinghouse Electric & Manufacturing Company and American Telephone and Telegraph Company, to American Transformer Company, dated February 1, 1927.

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Mr. Ashton: No objection.

(Marked Defendant's Exhibit E.)

Mr. Darby: I understand that the plaintiff is agreeable to stipulate that although that license agreement did not specify any patent by number, that all of the patents in suit were included in the license agreement.

Mr. Ashton: That is, the Radio Corporation had acquired rights under all of the patents in suit which it could grant for the specific purpose and for the specific limited field covered by the license.

Mr. Darby: You do not dispute that each of the patents in suit were thereby included in that agreement, within that specific field, for that specific purpose?

Mr. Ashton: As were other patents.

Mr. Darby: Yes. It is also stipulated that the vacuum tubes employed by the defendant were purchased from radio dealers, that is dealers in radio equipment, and were vacuum tubes manufactured by the Radio Corporation of America.

The Court: Were they manufactured pursuant to the provisions of Exhibit E?

Mr. Darby: No sir; they were manufactured under a vacuum tube license. If the Court please, on the patent side of this case Mr. Berliner, who is going to handle the other side of it, prefers that I go ahead with the patent side of it, and I am very much averse to using expert witnesses where the Court has been familiarized with the subject matter; as in this case. I think Mr. Waterman has done a splendid piece

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of work in familiarizing the Court with the particular subject matter of this case. I have an expert prepared to testify if the Court feels that it will be helpful. All I intend to do in connection with the prior patents that are relied upon is to offer them in evidence and point out to your Honor—I will do it personally if your Honor is of the belief that an expert will not be necessary—point out in a very few words in connection with each patent just what part is being relied upon, and then we can say in briefs or oral argument everything that could be said by testimony. It is a mere matter of understanding that this is a condenser, that that is an inductance, and that that is the circuit in which it is connected. I have an expert who is prepared, if your Honor believes that is necessary, but I think I can cover the whole thing in half an hour on the patent side of the case.

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The Court: Such suggestions of information as I have been able to gather from time to time should be amplified in this case, Mr. Darby. But that is not as important as the question of your record. If you are seriously going into the question of invention any conclusion that is reached should be supported by testimony and not by argument.

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Mr. Darby: The determination rests entirely upon a comparison of the circuit, and the only doubt in my mind is whether or not with what your Honor has already grasped in connection with this litigation

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you feel able to make that comparison when the particular instrumentality is pointed out to you. I might illustrate what I mean by this. I went over in cross-examination of Mr. Waterman just what instrumentality is selected by the patentee to illustrate his invention. If I show that identical instrumentality and identical arrangement in the prior art that is all that is necessary.

647

The Court: But it seems to me you must show it was the result of testimony and not the result of argument, in order to have a finding which would hold water.

Mr. Darby: All an expert can do is merely point out what the drawing shows and if the drawing does not show it all the expert testimony in the world will not help it, and if it does show it all the testimony in the world will not support it.

The Court: I feel that is the safer way for you to present your case, however.

648

Mr. Darby: I offer in evidence a folder containing 32 patents of the prior art, which I have arranged for the convenience of the Court with suitable indexes, and for the convenience of the Court I have included in there an extra copy of each of the patents in suit.

Mr. Ashton: There may be some objection, until Mr. Darby tells me exactly what patents he is relying upon in connection with the list which he supplied me on February 5th. There were in that list supplied at that time six patents which had not previously been called to our attention

under the requirement of the Statute, of giving thirty days notice. As to any such patents or any additional ones that Mr. Darby may have included in his offer, I would object unless they are offered only for the purpose of showing the state of the art as distinguished from anticipations.

The Court: Do you claim anticipation with reference to any?

Mr. Darby: Yes. Which are the six patents, Mr. Ashton?

650

Mr. Ashton: The six patents are Langmuir 1,313,094—

Mr. Darby: Which is being used to show the state of the art. What is the next one?

Mr. Ashton: Kendall 1,330,471.

Mr. Darby: My impression is that that patent is pleaded. Subject to checking it up—

Mr. Ashton: No, that is not.

Mr. Darby: If it has not been pleaded it will be used for the art.

Mr. Ashton: In my statement as to pleading I mean pleaded as to the particular patent in the bill of particulars which the defendant was required to file.

651

Mr. Darby: If it was pleaded in the particulars it is available for all purposes.

Mr. Ashton: Not unless it was pleaded as to the particular patent.

Mr. Darby: I question that.

The Court: Let us find out if it is mentioned in the bill of particulars.

Mr. Darby: I do not think it is mentioned at all.

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Mr. Ashton: I do not know as to what patent you are citing it.

Mr. Darby: I might explain to your Honor that when we moved to segregate the issue of law from the patent, up to that time no search had been made of the prior art, therefore Judge Coleman allowed us I think something like thirty or sixty days to have that search made. With eight patents in suit that was a colossal task.

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Mr. Ashton: It was three years before that.

Mr. Darby: I know, but you had five years to bring this suit to trial and did nothing about it.

Mr. Ashton: It is not in any bills of particulars.

Mr. Darby: You are sure about that?

Mr. Ashton: Yes.

Mr. Darby: Subject to that check we will use that one to show the state of the art.

654

Mr. Ashton: The next is Weagant 1,348,108.

Mr. Darby: All right, state of the art.

Mr. Ashton: The next is Johnson No. 1,432,863.

Mr. Darby: State of the art.

Mr. Ashton: The next is Arnold No. 1,504,537.

The Court: Just a minute, I do not see that in this list.

Mr. Darby: It is patent marked K, your Honor, in the index, and your Honor will notice that that is down at the bottom of

the index and I will explain its purpose right now. Four of the patents in suit are divisions of the parent application and that particular patent was held invalid by the Court of Appeals, in the Wallerstein suit, and I wanted to have before the Court the original patent which was held invalid in the Wallerstein suit.

The Court: Very well, we have that straightened out. I understood Mr. Ashton to say six patents and I have only four. This Arnold patent makes five.

Mr. Darby: As to the state of the art.

Mr. Ashton: That is right. I am sorry, your Honor, I overlooked one. Patent No. 1,398,665, to Arnold. That also is not pleaded.

Mr. Darby: State of the art.

Mr. Ashton: I should add as those patents in this group, as to which their filing dates merely were earlier than the application of the patent in suit, to which they are cited, that objection is made to their receipt in evidence, excepting on the ground that they are for prior invention. I think your Honor understands that an application filed earlier can only be used as evidence of prior invention, not as showing the state of the art.

The Court: You are now arguing again on the weight of the evidence, are you not?

Mr. Ashton: No, I am objecting to those particular, patents that were not cited in the answer.

The Court: But you are not specifying

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anything. That is too broad and comprehensive an objection.

Mr. Ashton: I will name those patents. Langmuir Patent No. 1,313,094, is based upon the application filed October 29, 1913.

The Weagant Patent 1,384,108, which is based upon the application filed April 9, 1914.

Mr. Darby: Just for your Honor's notation, perhaps I should draw your attention to a decision by Judge Campbell in the Yale Hook and Eye case, 33 Fed. 2nd 295, which establishes the pertinency of these patents and utility of them, as showing the state of the art.

Mr. Ashton: It is a question of law, your Honor. I might suggest as to that, that the Court might like to reserve ruling, because it depends upon a question of law, which would have to be argued.

The Court: Do you press the objection?

Mr. Ashton: Yes, I press the objection, your Honor, because it is very clear, as I understand the authorities, where an application has been filed, it can be offered only as showing prior invention.

The Court: Decision reserved.

RAYMOND T. CLOUD, called as a witness on behalf of the defendant, having been duly sworn, testified as follows:

Direct Examination by Mr. Darby:

Q. Mr. Cloud, please state your experience in the field of thermionic amplifiers; state your pre-

liminary education and whatnot which qualifies you to testify as an expert in this art. A. I graduated from high school and attended the University of Texas.

Q. In what course? A. In the electrical engineering course. I was unable to complete the course, due to financial trouble in the family, and I left the school and entered the electrical engineering work, which I have since been engaged in.

Q. When did you enter the electrical engineering work? A. In 1902.

Q. How long have you been familiar with thermionic amplifiers? A. Since 1912.

Q. Has your work been continuously connected with vacuum tube amplifiers since that time? A. My professional work has not been continuous, it has been in intervals, during that time, but it has been continuously since 1928.

Q. And in any particular branch of the industry? A. No, mostly relating to talking picture work and general amplification.

Q. Have you made inventions in the vacuum tube amplifier field? A. Yes, sir.

Q. On which you obtained patents? A. Yes.

Q. Approximately how many? A. I have made three inventions in the vacuum field and about eight in electrical allied fields, all of them relating to sound amplification.

Q. Since 1928, has your time been devoted practically exclusively to talking motion picture work and the electrical phases of it? A. Yes.

Mr. Darby: In the hope that it might be of benefit to your Honor, as well as to opposing counsel, may I, in taking up all of

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these patents, read into the record the particular patents which are going to be referred to with respect to the particular patent in suit. I know that Mr. Ashton will appreciate that, because he has asked me for it.

The Court: All right.

Mr. Darby: Referring to Lowenstein Patent 1,231,764, the following patents in the prior art will be referred to:

665 De Forest No. 841,387, which is tab No. 1 in your Honor's book.

De Forest No. 879,532, which is tab No. 2.

Stone & Cabot No. 884,110, which is tab No. 3.

De Forest No. 995,126, tab No. 4.

Von Lieben & Reisz 1,038,910, which is tab No. 6.

Q. Will you please refer to the De Forest No. 841,387, and particularly Fig. 2 thereof. Refer to the vacuum tube *a* of filament *E* heated by the battery *B¹*, which is the control electrode corresponding to the grid of the grid type audion. A. *D¹* is the controlling electrode.

Q. What is the element marked *B¹¹*? A. That shows a battery in the control circuit.

Q. That is in the circuit connection between the grid and the filament? A. Yes.

Mr. Darby: I might interpolate to state, your Honor, that this is one of the two original De Forest patents, that was sustained in this Circuit and practically throughout the United States wherever it



became involved with the audion as an amplifier.

Q. And what is the device marked R in the output circuit of that structure? A. That is the receiver, or any receiving device in connection with the output of the tube.

Q. Is the battery B, the output circuit, source of supply? A. Yes, that is the source of the space current for the vacuum tube.

Q. And in all vacuum tube arrangements with which this case is involved, there must be employed some space current in the plate circuit of each tube, is that right? A. Yes.

Q. In this arrangement, with the De Forest devise, referring to Fig. 2, is the vacuum tube a used as an amplifier or as a detector? A. It is used in both relations, principally as a detector; a detector tube always amplifies.

Q. I think you perhaps made a mistake in connection with that and I call your attention to page 2 of the patent, line 31, which says:

"In Fig. 2 I have shown the line F as constituting the local circuit of a wireless telegraph receiving system including the battery B¹¹ and oscillation detector T¹¹, the latter being connected in series with the antenna V and the earth E¹."

With that in mind, can you state— A. With that in mind, it is the amplifier.

Q. Is it an amplifier of low frequency currents or high frequency currents? A. Low frequency currents.

Q. That is audible frequency currents? A. Yes.

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Q. What is the character of the frequency currents that are handled by the defendant's apparatus in this case? A. Audio frequency currents.

Q. In other words, low frequency currents, is that right? A. Yes.

Q. Will you turn to De Forest Patent 879,532, tab No. 2.

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Mr. Darby: I might also tell your Honor that this is the patent—the original patent of the grid audion patent which has been sustained throughout the United States.

Q. (Continuing.) Is the vacuum tube D shown in Fig. 2 of the same type that was employed as the amplifier, as illustrated in Fig. 2 of the De Forest Patent 841,387, which we last considered? A. Yes.

Q. And which is the control electrode? A. The control electrode in this case is A¹.

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Q. In this instance, is the tube D in Fig. 2 acting as both a detector and an amplifier? A. Yes.

Q. In what respect does the circuit arrangement of Fig. 1 differ from that of Fig. 2? A. Mostly with regard to the tubes themselves, the construction of the tubes.

Q. That is the grid electrode A of Fig. 1 has been substituted for the plate A¹ of Fig. 2, is that correct? A. Yes, the control electrode in Fig. 1 has a grid interposed between the filament and the anode, whereas in Fig. 2 it is an auxiliary plate.

Q. Now, will you please refer to Stone &

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Cabot Patent 884,110, which is tab No. 3, your Honor; what is the stated object of the invention of this patent? A. The object of the patent is to provide a detecting device, and the object is to improve the sensitiveness of the oscillation detector.

Q. And this vacuum tube detector is also inherently an amplifier? A. Yes.

Q. And it is that factor that made it a successful detector? A. Detection is amplification in which one-half of the wave is amplified more than the other in the case of the vacuum tube detector. 674

Q. Which is the controlling electrode in the audion structure shown by Stone & Cabot? A. G¹.

Q. And what constitutes the input circuit? Trace it, please. The input circuit, starting with the filament is constituted by a secondary of an oscillation transformer I2 shunted with condenser C and from thence to the negative side of an auxiliary battery from the positive side to the grid and the voltage is created between the filament and the grid for control of the electron flow. 675

Q. In what respect, if any, does this disagree from the asserted invention of the Lowenstein patent? A. Only in the polarity of the battery.

Q. That is, in Lowenstein, he impresses a negative potential on the grid electrode, whereas Stone & Cabot impress a positive potential, is that right? A. Yes.

Q. Now, will you please refer to De Forest Patent No. 995,126 (tab No. 4, your Honor), refer to Fig. 2 of that patent. I notice that the polarity of the battery marked B for lighting

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filaments, is indicated by the minus and positive signs, and that is true in connection with each instance where the grid type of audion is shown, so that the negative side of the battery is the side which is always connected to the grid electrode; do you check with me on that? A. Yes.

Q. What effect has the connection of the negative side of the filament battery on the polarity of the grid? A. The negative side of the battery, when connected to the grid, makes the grid negative relative to the filament, especially in the case of filaments that are not uni-potential. That is, there is a steady drop of potential across the filament and the current traverses it. So the grid on the side it is tied in is at zero potential, whereas as to the most positive side of the filament, it is negative with regard to the total drop of the filament. In other words, if the total current drop of the filament was 5 volts, the grid would be at the negative end, would be at zero potential, at the positive it would be 6 volts, negative to the filament, making an average of one-half or two and a half volts negative.

677 Q. Now, if you will turn back for a moment to the De Forest Grid Audion Patent (tab No. 2) 879,532, is the filament lighting battery A there likewise connected with its negative terminal to the grid electrode? A. It is.

Q. This is the control electrode? A. Yes.

Q. Is that likewise true with respect to Fig. 2? A. Yes.

Q. Will you turn back once more to the original De Forest Vacuum Tube Amplifier Patent Fig. 2, and I call your attention to the fact that the control electrode as you have previously testified is the right-hand electrode D¹, and has the

polarity of the A battery B1 been arranged so that its negative terminal is connected with the control electrode? A. It is.

Q. Will you now please refer to the Von Lieben & Reisz Patent (tab No. 6) No. 1,038,910, and will you please call to the Court's attention what this patentee has to say with respect to the matter of potential on the grid, particularly the matter beginning at page 1, line 25 and extending to line 51? A. He says:

"The subject of the present invention is further development of the above-mentioned invention wherein instead of being altered indirectly by means of an ionizer, the resistance on the main circuit is altered directly by means of the auxiliary electrode, on which the currents to be reinforced act. For this purpose the auxiliary electrode, which is likewise made of grid or net form, is arranged in such a manner that it completely intersects or divides the space between the cathode and anode in the discharge tube; moreover, it is connected with the source of direct current in such a manner that it is an exactly defined potential corresponding to the degree of reinforcement required for the time being.

"In order to enable this potential to be adjusted as required, an adjustable resistance is preferably introduced between the electrode and the source of electric current. By this means the valve-like action of the incandescent electrode is dispensed with, since the alternating current to be

682 *Raymond T. Cloud—For Defendant—Direct.*

reinforced is superposed on the constant direct current whereby an undulatory current is formed from the alternating current.”

Q. Now, will you please point out in Figs. 2 and 2-A of this patent how that effect is obtained? A. In Fig. 2, he attains it by a fall of potential across his cathode filament potentiometer arrangement C, he can thus create the potentials relative to the auxiliary electrode,

683 Q. Which is auxiliary electrode, H? A. H is the auxiliary electrode.

Q. This is the controlling electrode? A. That is the electrode.

Q. Corresponding to the grid of the vacuum tube? A. Yes.

684 Q. All right. A. And the microphone M through a transformer primary on which is marked P and S representing the secondary source of current for the microphone being H superposed upon this direct current created between H and the cathode K, the variable currents amplified by the circuit composed of anode A, output transformer S¹ and P¹, and sources of current not shown, merely marked “Positive” and Q to the negative side of the filament.

In Fig. 2-A he shows a polarizing battery B¹ as the source of his auxiliary current. This circuit is between—he has two cathodes in this tube, K and K¹; K¹ being the working cathode interposed in the auxiliary circuit. B¹ is the polarizing battery, similar to that of Stone, and before that of De Forest, and the manner of operation is similar to Fig. 2, inasmuch as the current of the microphone is superimposed upon the control

grid circuit to control current in the output of the anode of the tube.

Q. With the battery connected as there shown with the positive terminal, and I am referring to battery B¹, with the positive terminal towards the grid electrode, would the grid electrode be more positive or more negative with respect to the cathode K¹? A. It would be more positive.

Q. Now take up consideration of Mathes patent No. 1,426,754. As against that patent we will use Arnold Patent No. 1,129,942, Tab. No. 10; Arnold Patent 1,129,943, Tab. No. 11; Reisz Patent No. 1,234,489, Tab No. 16; Colpitts and Arnold Patent No. 1,388,450, Tab No. 27. Will you please refer to Arnold Patent No. 1,129,942, Tab No. 10. A. We have a diagram in connection with that (handing counsel).

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Q. Will you please refer to Fig. 5 of that patent. A. Yes.

Q. How are the audion tubes numbered 1 and 2 connected, in series or in parallel? A. In series.

Q. Are the filament electrodes heated from separate, independent sources, or are they heated from a common source? A. The filament electrodes are heated by a common source, battery No. 12.

687

Q. Are the grid electrodes 3 and 7 of the middle and last tube provided with means for maintaining them negative with respect to the filament? A. They are.

Q. What are the means? A. The means for providing them negative are the C battery 11, resistance 14 and the resistance of the filament of the first tube 5.

Q. Is the filament of a vacuum tube similar in principle and operation to the filament of an

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incandescent lamp? A. Yes, it is very similar; they have similar characteristics.

Q. And when the vacuum tube is lighted is the filament heated to incandescence? A. Yes.

Q. And what makes it visible to the eye, is it the resistance of the filament which causes it to become heated? A. Well, it is the effect of the resistance. It is the power dissipated through resistance.

689 Q. So an ordinary incandescent light filament or an audion tube filament is a resistance element? A. Yes.

Q. If the battery 11 were removed from the circuit, what would be the potential on the grid electrodes of the tubes 1 and 2? A. We will take 2 first. If the battery 11 were removed, the potential on the grid would be the potential of battery 13 in a positive direction minus the drop of potential across the resistance of filament 5 of the first tube minus the drop of the space current of the first tube through resistance 14.

690

The Court. Minus what?

The Witness: Minus the potential drop across resistance 14 of the space current for the tube No. 1.

Q. Have you prepared a simplified drawing showing the circuit insofar as it is pertinent to the present case, of Fig. 5 of this Arnold patent? A. I have.

Q. Will you please produce it? A. Yes (handing counsel).

Q. Have you checked this simplified drawing, and can you vouch for its accuracy in simplified form? A. I can.

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Mr. Darby: I offer it in evidence.
(Marked Defendant's Exhibit G.)

Q. Will you please briefly describe the arrangement there shown? A. This is the drawing of Fig. 5 of Arnold Patent 1,129,942, in which I have substituted the resistance of the filament of the first tube as shown by R1 in the drawing. The filament battery reverses resistance R2, which is representative of the tubes No. 3 of the patent drawing as well as, I believe there is a resistance 14—yes. Through the filament of the second tube, through resistance R1 which is that of the filament of tube No. 1, thence to the negative pole of the battery. A potential drop of voltage is created across resistance R1. This R1 is also included in the grid circuit of the input to tube No. 2, represented grid No. 1, including the B battery E9, resistance R8 and C battery E6. The resultant negative potential impressed upon the grid would be E9 minus E6 minus all of the sum of E6 plus R8Ip plus R1 If.

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Q. What is the significance given in the patent for the spacing of the plate electrode relative to the filament electrode as diagrammatically illustrated on Sheet 2 of the drawings, and more specifically illustrated in Sheet 1 of the drawings? A. You are referring back to the patent now?

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Q. Yes. A. The patent itself?

Q. Yes; has that to do with controlling the internal impedance of the tube? A. Yes, the spacing of the plate relative to the filament has to do with the internal impedance of the tube as well as the other factors.

Q. Now will you please refer to Arnold pat-

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ent No. 1,129,943, Tab No. 11. Are the tubes there illustrated likewise cascaded or series amplifiers? A. They are.

Q. From what source are the respective filaments heated? A. In Fig. 1 they are heated by separate batteries numbered 7 in each case; Fig. 2 they are heated also by a common battery source, No. 7.

Q. Is the grid electrode of each of the tubes biased? A. They are.

695 Q. How? A. They are biased by means of biasing battery 6, the drop of potential across the resistance 8 and the B battery 9, and also, in the case of all except the first tube, by the filaments of all of the preceding tubes.

Q. I notice that Battery 12 apparently impresses a bias on the grid of the next to the last tube of a positive character, as well as the grid of the last tube; is that correct? A. That will depend upon the preceding biases.

Q. In other words, if the preceding biases—
A. If the preceding biases, including [redacted] filaments and drops across the resistance, if they were too highly biased by battery 6, then 12 may only reduce the amount of negative bias on the tubes.

Q. I notice that each of the grid electrodes of the tubes other than the first tube is connected through a circuit which leads to the negative side of the battery 7; is that correct? A. That is correct.

Q. If the biasing batteries 6 and 12 were eliminated, taken out of the circuit entirely, what would be the potential of the grid of all of the tubes except the first tube relative to the filaments of each tube? A. The potential of the grid

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would be the potential of B battery 9 minus the drops of potential across resistances 8, minus the drop of potential through the filaments of the preceding tubes. By preceding meaning from the negative end of the A battery.

Q. And would you not likewise have to subtract the potential of the battery 7? A. Well, you would only have to subtract the potential of battery 7 to the extent of the potential that was expended in the resistance of the tubes to the left of each one of the tubes you are considering. 698

Q. Now will you refer to Reisz Patent 1,234, 489, Tab No. 16? A. Yes.

Q. In this arrangement the filament derives its heating current from battery B, does it not? A. It does.

Q. And connected across the battery B is a potentiometer or resistance W1, is that right? A. Yes.

Q. From which is tapped an adjustable connection to the grid electrode 8, is that right? A. Yes, that is right. 699

Q. Now, what is the potential of the electrode H relative to the potential of the filament K? A. The potential of H is at some intermediate point relative to the potential K depending upon where the connection is made to the resistance, this potential being derived by the fall of potential through the resistance W1.

Q. Now as I understand you, you made reference earlier in your testimony to this, let us consider the filament K for a minute; it consists of one leg that runs through the tube upwardly into the shape of a W and then down through the bottom of the tube? A. That is right.

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Q. What is the potential of the filament at the W part, relative to the left or entering leg? A. At the W part of it relative to the left entering leg it would be positive to the entering leg at the left.

Q. And what would be the potential of the right leg relative to the left entering leg? A. The potential of the right leg would be positive relative to the entering leg.

701 Q. What would be the potential of the W relative to the right leg of the filament? A. It would be negative to the right leg of the filament.

Q. Therefore, if, the grid electrode tap connection made to W¹ was moved entirely to the left of the potential W¹, what would be the potential of the grid electrode H relative to the filament? A. It would be an average negative potential of one-half the negative potential.

702 Q. If the tap connection was moved entirely to the right end of the potentiometer W, am I correct or not in understanding that the potential of the grid H would then be positive with respect to the average one-half of the filament potential? A. It would.

Q. Now, will you please turn to Colpitts and Arnold Patent No. 1,388,450 (which is tab No. 27, your Honor), referring to Fig. 2 and the right-hand corner thereof, there are two vacuum tubes, the audion tubes 27 and 28 there shown; are they used as amplifiers? A. They are.

Q. Will you briefly describe the arrangement there shown for heating the filament, having particular reference to page 2, line 122 and page 3, line 2, inclusive and state what the polarity of the grid electrode is relative to the filament and how that polarity is obtained?

"Where an alternating current source is employed for this purpose, the filament circuit should be shunted by an inductance 62, the middle point 63 of which is connected to the output circuit through a resistance 64. Each half of the inductance 62 is shunted by a condenser 65."

Here we have the filament heated by an alternating current generator No. 61 and the two filaments are in what is called parallel connection, as differentiated from the series connection that I discussed before.

704

Q. That is with the Arnold patent? A. That is with the Arnold patent. I believe that the reason for resistance No. 62 and for connecting in the center tap was explained thoroughly by Mr. Waterman when he was on the stand and discussed similar matters, and I won't attempt to go over it again unless you have some questions in connection with it.

Resistance 64 is connected from the center tap, resistance 62 is the return circuit for the two tubes 27 and 28. I trace that circuit from generator 66 which supplies the space current, the positive side goes through the primary of the output transformer 38, divides and goes through the two tubes 27 and 28, flows from the plate on each of these tubes to the filament, thence re-united at the junction point just above 62—they reunite at the junction point of 62 and traverse resistance No. 64.

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The direction of the current is such that the top end of 64 is the positive and the lower end is negative. This resistance is also included in the grid input circuit starting from the bottom

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of 6 through the resistance condenser and transformer combination No. 60, 59 and 58 to the grids of the respective tubes Nos. 27 and 28. The drop of potential thus creates a negative bias upon the tubes 27 and 28, equivalent to the voltage expended in resistance No. 64.

Q. And is the negative bias that is effected on the grid in defendant's apparatus similarly effected by means of the drop of potential across resistance included in the current supply circuit? A. It is.

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Q. Now, we will take up consideration of the Arnold patents. Take up first Arnold Patent 1,329,283, the Power Circuit Patent in connection with which, we will consider Seibt Patent 1,012,456, tabbed No. 5; Arnold Patent No. 1,129,943, tabbed No. 11; Colpitts Patent No. 1,129,959 tabbed No. 12; Langmuir Patent No. 1,558,436, tabbed 32.

708

Referring first to the Seibt patent, tabbed No. 5, in what particular art is this classified? A. It relates to radio telephony and does not involve the vacuum tube.

Q. Will you call the Court's attention to the matter beginning at line 38 on the first page?

"According to the present invention the variable resistance is brought into such relation to the fixed resistance that the variation of pressure produced by the acoustic vibration cause a maximum variation of radiated electrical energy."

And then he goes on to work out through a set of mathematical formulas that I don't think is necessary to attempt to follow.

Q. Before you go into the mathematical formulas, let me read this statement to you:

“In the case in which the oscillations are produced in the antenna itself or transferred to it by loose coupling from a closed oscillation circuit and assuming the microphone to be inserted directly into the oscillation circuit, theory shows that resistance of the microphone ought to be numerically equal to the other resistances of the antenna or, in other words, that the damping produced by the micro-antenna itself.”

In this radio telephone system, is there an input circuit and output circuit? A. There is.

Q. What comprises the input circuit? A. The microphone itself is an input circuit.

Q. What is the output circuit? A. The output circuit is the antenna.

Q. Referring now to page 2, line 3, after the mathematical discussion you referred to, appears the statement:

“Hence the condition for maximum efficiency is that the resistance of the microphone and of the system to which it is connected should be equal.”

What is the significance of that statement? A. The significance is that it seems to be a universal law, wherever energy is taken from a generator of any kind whatever, that the condition for maximum efficiency shall be when the exterior resistance is equal to the internal impedance of the device.

712 *Raymond T. Cloud—For Defendant—Direct.*

Q. Now, will you refer to Arnold Patent 1, 129,943, tab No. 11. This patent you previously considered with reference to the Mathes patent, and will you briefly review the subject matter contained in lines 11 to 34 of the patent? A. I will read the lines first:

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"This invention relates to the use of thermionic repeaters, such as the audion, as amplifiers without transformers, and more particularly to the use of thermionic repeaters for securing amplifications of current in circuits of low impedance.

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"In many instances it is necessary or desirable, for securing the best results, to exclude transformers from the circuit. Such is the case, for example in those circuits in which the frequency is so low that efficient transformers are costly and difficult to design, as is the case in telegraph circuits in general and especially in submarine and wireless telegraph circuits. It is particularly desirable to exclude transformers from circuits in which an exact reproduction of wave form is necessary for legibility, as for example in submarine cable circuits. It is also desirable to exclude transformers from circuits in which undistorted amplification must be secured over a wide range of frequencies, as, for example, in the reproduction of speech and music."

In this case, he is trying to secure the most efficient results by building his tubes or arranging his tubes in such a manner as to meet this

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universal law of getting the load somewhere of the same order as the output impedance of the device without the use of transformers, such transformers acting as a magnifier of currents.

Q. And does he connect audion amplifiers in series without the use of transformers? A. He does.

Q. Now, referring to lines 41 to 48, he states that:

"The impedance of the input circuit of an efficiently operating audion of the usual type is very high, at least 100,000 ohms, and in general as high as 10 megohms."

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As translated by Mr. Waterman, that would be equivalent to 10,000,000 ohms, is that right? A. Yes, that is right.

Q. Will you now explain the significance of the statement made, page 1, line 62 to line 93?

A. (Reading):

"It has been discovered that audions may be so constructed that without the use of transformers, they will step up the input voltage of either direct current or alternating current of any frequency in one step to as much as thirty times its original value, or in two successive steps to as much as 500 times its original value. The voltage amplification thus secured is entirely free from wave distortion whatever may be the initial frequency and wave form. It has been discovered that the output voltage of one of such audions or of a plurality thereof in tandem may be stepped down and the resultant current greatly amplified by having such audion

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or plurality of audions work into a plurality of similar audions in multiple, with the output of each going to a common circuit. This common output will be an amplified current of relatively low voltage. It has been discovered that a combination of one or more such audions working into a sufficiently large number, for example from fifty to one hundred, of similar audions in multiple, with a common output, will operate, without transformers, from a line of low impedance, for example 250 ohms into a light line with a resultant current much greater, fifty or more times as great, than would flow in the second circuit if it were directly connected to the first circuit."

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Mr. Darby: I call the Court's attention to the fact that in lines 95 to 101, reference is made to the fact that he had produced a specific type for doing this, identifying it by serial number filing date, and that is the audion shown in Patent No. 1,129,942, tab No. 10, with the spaced electrodes for the purpose of obtaining impedance effect. It is on the second sheet.

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The Court: Yes.

Q. On page 2, line 8 $\frac{1}{2}$ will you please read what is there said with respect to the audion construction in so far as it affects the internal impedance of the tube? A. (Reading):

"The several audions may be of the usual construction, but to secure most efficient results the input electrode may be in the form of a grid 1, preferably

made of very fine wire with a fine mesh or the like, and the output electrode or plate 2 is placed at a considerable distance from the filament 3. The filament, grid and plate are as usual sealed in an evacuated bulb. In order to secure best results, the grid should be near the filament, the plate should be distant from the filament, and the grid should present a finely meshed or discontinuous surface between the filament and plate. This type of audion is adapted to give an amplification with low current and high voltage in its output circuit."

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Q. Do you consider those statements correct as to the bearing on the matter of the internal impedance of the tube? A. The grid has little bearing upon the internal impedance of the tube, that is as far as the geometrical structure is concerned.

Q. That is the impedance between filament and plate? A. Impedance between filament and plate.

Q. You agree with Mr. Waterman on that then?

A. Yes.

Q. Beginning at line 42, the statement is made:

"The output circuit of each audion includes its output electrode or plate 2, a high resistance 8, a battery 9 and the filament of the audion. The resistance 8 should be, for example, 100,000 ohms or more."

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Do you consider that to be a high resistance? A. Yes, I consider 100,000 ohms a high resistance in the plate circuit.

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Raymond T. Cloud—For Defendant—Direct.

Q. From your knowledge of audion tube amplification, I call your attention to the statement beginning at page 2, line 73:

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“By combining two or more audions in tandem working into a number of audions in multiple, for example, from ten to one hundred, the combined system will operate without the use of transformers, from an incoming line of low impedance with a resultant current of more than fifty times that which would flow in the outgoing line if the latter were directly connected to the incoming line.”

You have no reason to question that? A. I have no reason to question that.

Q. Then at line 105, the statement is made:

726

“The invention is also particularly adapted for use in circuits where especially pure or loud reproduction of speech or music is desired.”

What do you understand is meant by the term “pure” as there used, undistorted? A. Undistorted.

Q. What if anything does this patent teach you with respect to the matter of matched impedances? A. It teaches me that it is of primary importance where you want to get maximum efficiency out of the tube.

Q. That is, the output impedance should be matched by the internal impedance of the tube?

A. Yes.

Q. Will you next turn to Colpitts Patent 1,129,959, tab No. 12.

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Mr. Ashton: If you have no serious objection, I would like to point out to the Court that this Arnold patent to which we have been referring was filed on the same day as the application upon which the Arnold patent in suit, No. 1,329,283, the patent to which Mr. Darby has been referring, was granted.

Mr. Darby: Wait a minute. Which patent was I referring to?

Mr. Ashton: The patent in suit goes back to the same date as the date in the Arnold patent.

Mr. Darby: One of us is mistaken, Mr. Ashton. One of us is very much mistaken. The Arnold patent in suit was applied for July 30, 1918.

Mr. Ashton: It is a continuation of part of the original application 841,567 filed May 28, 1914.

Mr. Darby: That is not what you said. It is a continuation, but the legal status of a continuing application is something that this Court is going to pass on. The application which matured in the patent in suit was filed July 30, 1918.

Q. Will you now turn to the Colpitts Patent. I think I have given you the data on that. Before referring to the drawings, I call your attention to this statement appearing on page 1, line 19:

"A well known law of electric circuits requires that the impedance of the external path in the circuit should be equal

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to the impedance of the internal path or source, whenever the maximum of available energy is desired."

Is that a correct statement? A. That is correct.

Q. What do you understand to be the asserted invention of the Arnold patent No. 1,329,283 under consideration? A. I understand that the invention relates to matching the output impedance of the tube with an external impedance of the same order.

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The Court: Is there anything in the claims on this patent in suit?

Mr. Darby: The prior art patent?

The Court: Yes.

Mr. Darby: I call your attention to Claim 1. I have marked it, and I don't know whether this patent is being used for a defense to one of the other patents or not. I can tell your Honor in just a minute.

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The Court: Claim 1 you called attention to?

Mr. Darby: Yes. No, I marked that claim 1 in connection with another comparison.

The Court: I do not find anything in the claim about it, do you, because this is merely a recital in the specifications, but I asked you if there was anything, and you said this was.

Mr. Darby: I do not think there is any. I have marked a claim, but I see is to call to your Honor's attention another patent in suit. Of course your Honor

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understands that irrespective of what is claimed, it is what is disclosed that is material. Now I call your Honor's attention to this statement—

The Court: I also understand that that depends on which side of the case you are on.

Mr. Darby: Yes, sir; very much.

Q. I call your attention to this statement of various types of known amplification devices. Line 45, your Honor:

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"Of the various types of known amplifying devices, those in the general class of vacuum discharge repeaters such as the ionized gas type and the type known as thermionic exemplified by the 'audion' have advantages with respect to amplifying very low frequency currents, since the output currents in such devices are not subject to severe distortion due to external or internal disturbances, but are substantially determined as to their form by the form of the input current."

735

Can you very briefly describe what is meant by that statement? A. The statement refers to the fact that the tube of the audion type will amplify without distortion, in effect is what it means, that this grid does not draw any current from the source.

Q. I likewise call your attention to the statement beginning at page 1, line 101:

"The unbalanced condition and inefficient operation which would be met in the use without a transformer of any known

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type of vacuum discharge repeater and the necessity of using the undesirable transformer to balance impedances are at once avoided in accordance with this invention by the use of two or more vacuum discharge repeaters having different impedance characteristics and working one into the other by direct connection. Two such vacuum discharge repeaters may be placed in seriatim between the cable and receiver, the one connected with the cable having high output impedance and preferably also a comparatively low input impedance such as the ionized gas repeater, and the one or more connected with the receiver having high input impedance such as the audion, and preferably arranged to offer a comparatively low output impedance."

Now, referring to the drawing—

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The Witness: Yes.

Q. Now, referring to the drawing, what is there illustrated as an ionized gas repeater? A. The device shown to the left of the figure 1 shows a form of ionized gas repeater.

Q. And the audion tubes numbered 6, 7, 8 and 9 are not the ionized gas repeaters that he refers to there, are they? A. No.

Q. These audion tubes are connected in series, are they not? A. The filaments are in series, but the plates and grids are in parallel.

Q. And are they used as amplifiers? A. They are used as amplifiers.

Q. Now at line 124 this statement is made:

"The different parts of these circuits are or may be balanced electrically in the following manner: the electromagnet 4 of the gaseous repeater 3 may be wound to any impedance desired, thus making it of an impedance of the same order of magnitude as the cable from which it receives energy. By using a number of audions in the way shown in Fig. 1, the combined impedance of the output circuit may be made of the same order of magnitude as the receiver or siphon recorder. The output-input circuit between the gaseous repeater 3 and the audions is naturally well-balanced, inasmuch as the output circuit of the gaseous repeater and the input circuit of the audions are both of high impedance and approximately of the same order of magnitude."

740

What bearing has that statement on your testimony as to the teaching of this patent as to the advisability and necessity of matching the impedances? A. This features again the attempt to match up the impedance of the incoming line to the outgoing line so as to get the maximum efficiency of the repeater.

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Q. Now, if you will refer to Langmuir patent 1,558,436, which is tab No. 32—

Mr. Darby: I might tell the Court that this is the Langmuir patent for the so-called High Vacuum which was invalidated by the Supreme Court after a controversy

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Case.

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which started about 1915 and terminated the year before last in the Supreme Court, and in that decision, which your Honor will hear more of in the trial because of language that was employed, as particularly bearing on the radio industry and this particular art, one of the contentions made was that the geometry of tubes was an expression that was used throughout the trial and argued, and the geometry of the tube was one of the elements of the invention and necessary to be met in order to create high vacuum. It was a peculiar situation where the present plaintiffs and I as counsel—not this same counsel, the plaintiffs and I were combined in the fight against the General Electric Company, although we are split asunder here, and the only purpose of referring to this patent at all is because of the reference that is therein made to "the geometrical proportions of the device also affect the amount of current which will pass with a given voltage, but as these conditions remain fixed for a given device, they may be represented by a constant, an equation expressing the relation between the current and the voltage."

The Court: Have you, incidentally, a reference to that?

Mr. Darby: The Supreme Court decision?

The Court: Yes.

Mr. Ashton: It is reported in 283 U. S., 664, and the change in the opinion, which was made, as a result of the petition for

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rehearing, in the last page of the opinion, is in page 284 U. S., at page 571.

Q. We will now take up consideration of Arnold patent No. 1,349,252, which has been characterized as the Straight Line Characteristic Patent. The art that will be relied on in connection with that patent consists of Arnold 1,114,845, tab No. 8; Pierce, No. 1,127,371, tab No. 9; Arnold, No. 1,129,943, tab No. 11; Colpitts, No. 1,137,384, tab No. 13; Langmuir, No. 1,223,496, tab No. 14; Kendall, No. 1,330,471, tab No. 20; DeForest, No. 1,375,447, tab No. 24; Weagant, No. 1,384,108, tab No. 26; Hewitt, No. 1,393,369, tab No. 28.

746

Mr. Darby: Your Honor will recall, before I refer to this art specifically, that this is a patent which is indicated by the insertion of an additional impedance in the plate circuit.

Q. Now, will you please refer to Arnold patent No. 1,114,845, tab No. 8. Is there any additional impedance added to the output circuit of the circuit there shown in this patent, Mr. Cloud? A. Yes, in Fig. 1 and Fig. 3 there is an additional resistance 8 and condenser 9.

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Q. In Fig. 1? A. Fig. 1—No. 2, rather.

Q. Is there additional impedance of No. 3 consisting of the resistance 8 and the shunt coil of inductance 10? A. In that case the resistance is in shunt to the load.

Q. And if you will refer to Fig. 5 of the Arnold patent No. 1,349,252, the resistance R' is in shunt to the output circuit, is it not? A. Yes.

748 *Raymond T. Cloud—For Defendant—Direct.*

The Court: Would you mind having the witness define what he means by the term "in shunt"?

Q. Please state so. A. A resistance in shunt is the same as a resistance in parallel. It means that if, instead of being in series, as shown by Fig. 3, it would be shunted directly across the output terminals.

Q. That is, instead of being connected end to end to it, it is connected around it, is that right?
A. Yes.

Q. As a by-pass? A. So as to short circuit the device, in other words; the form of a by-pass.

Q. I call your attention to the statement contained in the Arnold patent—

The Court: That is what is indicated, is it, by R1?

Mr. Darby: Yes, sir; as Mr. Waterman testified, your Honor will remember, probably, in cross examination, that R1 is connected in shunt through that transformer.

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The Court: Yes.

Mr. Darby: In any one of these circuits this resistance is connected in series. If I want to connect it in series to this coil, for example, because it is connected end to end to it—if I wanted to connect it in shunt, I would connect it around this way (indicating), as a by-pass around here.

The Court: Yes.

Mr. Darby: That is what is referred to "in shunt."

The Court: Well, what was doubtful to me is this diagrammatic indication. That

looks like a separate unit. That is not connected, that portion, with anything.

Mr. Darby: Yes, sir.

The Witness: That is a transformer.

Mr. Darby: That is a transformer. That is the primary and secondary of a transformer, and if I can possibly clear your Honor's mind on the subject by referring to the next page of the patent you are considering, where it points out, "While the resistance has been shown as connected directly in the output circuit of Fig. 3," at the top of the page:

"While the resistance has been shown as connected directly in the output circuit of Fig. 3, it is to be understood that the invention is broader than this and that the resistance may be inserted in other ways. It may, for example, be carried into this output circuit by means of a transformer. That is, if as shown in Fig. 5 the resistance R1 is actually included in the secondary circuit of the output transformer, it will produce an effective resistance in the primary circuits yielding, to all intents and purposes, the same result as if a resistance had been actually placed in this primary circuit. The value of the effective resistance produced in said primary by a given resistance in the secondary circuit will, of course, depend on the ratio of transformation of the transformer."

And the whole theory of the operation of a transformer is that it passes from one circuit in which one coil of a transformer

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is included, this electrical effect into the next circuit into which the other coil of the transformer is included. Is that cleared up, your Honor?

The Court: It helps.

The Witness: That is, it can magnify the resistance or make it smaller.

Mr. Darby: That is, it can be a step-up transformer, or a step-down transformer.

755 Q. With reference to the resistance I find this statement in the patent, beginning at line 31:

“It has been found experimentally that the establishment of the condition of discharge described above as the blue haze may be prevented by placing, in series with the battery, a balancing resistance of such high value that the increase in current which would normally take place when the condition in the bulb corresponding to the blue haze exists, results in such an increase in fall of potential across the resistance as to render the maintenance of the condition corresponding to blue haze impossible.”

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Now, will you briefly explain that statement. A. This patent was directed towards the tube at the time that it was very difficult to get entirely free of the gases that were in the tubes, and occasionally they would get a sharp increase in voltage that would start ionization in which the electrons would come in contact with actual particles of gas, and in such cases they would create more electrons and this bombard-

ment and the current would very sharply rise, due to the fact that this ionization had taken place. The resistance was inserted in there for the purpose of limiting this sudden flow of current that took place when ionization takes place.

Q. Referring to the curves of the patent in suit which we are considering, take the curve of Fig. 4, for example, if a blue haze effect occurred, what effect would it have on the curve? Would it cause it to rise very sharply? A. Very sharply.

Q. And the purpose of putting this resistance in the plate circuit was to keep the curve straight or normal, whatever it may have been? A. Well, it is very difficult to say that a curve in a gaseous tube was straight, but it tended to keep—

Q. To keep it to a normal condition; is that right? A. Yes.

Mr. Darby: And in that connection I call your Honor's attention to the subject matter of the claim, the single claim here in the case.

Q. Does that patent teach that one cycle in the art, in your opinion, the utilization of a resistance in the output circuit of a tube to prevent deformation of the curve due to increased current on the input? A. It does.

Q. Now, will you please refer to Pierce patent No. 1,127,371, tab No. 9? I call your attention particularly to Fig. 2, in which a 3-electron audion type is shown, and ask you if any additional impedance or resistance is employed in the output circuit of that tube? A. Yes, resistance No. 39 is included in the tube.

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Q. And what function will that resistance in the tube plate serve? A. Well, it will serve to straighten the characteristic of the tube in the manner stated.

Q. In other words, if any resistance is included in the plate circuit of a tube, will it not inevitably and unavoidably serve to straighten out the characteristic of the tube? A. Undoubtedly, from zero on up.

Q. And all depending upon the amount of resistance that is put in? A. All depending upon the amount of resistance that is put in.

Q. I call your attention to Arnold patent No. 1,129,943, tab No. 11. Are any impedances or resistances included in the plate circuit or output circuit of any of those amplifier tubes? A. Resistances in Fig. 1, resistance 8 are included in the output of each of the tubes; in circuit 2, resistance 8 are included in the output of the tubes 1 and 2, and a single resistance 8 serves as an output for tubes 3, 4 and 5.

Q. I call your attention to the statement beginning at line 42 of page 2:

"The output circuit of each audion includes its output electrode or plate 2, a high resistance 8, a battery 9 and the filament of the audion. The resistance 8 should be, for example, 100,000 ohms or more."

What is the value of the resistance employed in the defendant's apparatus in that tube, where a high resistance is employed? A. They vary in the circuits as marked. In V1 it is 60,000 ohms; in V2 it is 6,880; in V3 it is 112,000 ohms; V4 and

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V5, the two in series, it is 645,000 ohms, and in V6 and V7 it is 5,000 ohms.

Mr. Darby: And I call to the Court's attention that it is charged that defendant infringes this patent in all of the apparatus, A-41, A-36 and PA-39. All of that is charged to be an infringement.

Mr. Ashfon: But not as to V2.

The Witness: Not as to V2.

Mr. Darby: But not as to V2 of A-41. 764

Q. Now, will you please turn to Colpitts patent No. 1,137,384, tab No. 13. Do you find any additional resistances or impedances included in the output circuit of any of the tubes shown in this patent? A. Yes, in Fig. 2 there is an additional resistance between the condenser 8 and terminal 5 of the transformer.

Q. And that is shown as an adjustable resistance, isn't it? A. Yes, an adjustable resistance.

Q. So that its value can be changed at will?
A. Yes.

765

Q. Now, will you please refer to the Kendall patent 1,330,471, Item No. 20? I call your attention to Fig. 4 and the intermediate vacuum tube circuit, the one in the middle. Is there a resistance or— A. Yes, marked 80.

Q. That is connected in the output circuit of the tube? A. It is.

Q. In addition to its ordinary load? A. It is.

Q. The patent states this, to which I call your attention, page 1, line 15:

"In wireless signaling, the extraordinary weakness of the received signals

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makes it highly desirable to use means for intensifying the effect produced on the translating device. In the case of wireless telegraphy, this is a comparatively simple matter, for the chief requirement is to obtain an indication, with small regard for the distortion produced. In the case of wireless telephony, however, where the high frequency carrier waves are modulated in accordance with the speech signals to be sent, the problem is much more difficult, for the intelligibility of the translated signals depends on the faithful reproduction of the modulations of the carrier waves. This means that the distortion must be kept to a minimum."

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Then on page 3, line 4:

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"In this Fig. 4, there is a different arrangement of output circuit for the detector. As shown in said figure, there is placed in series with the power battery 35 a high non-inductive resistance 80."

Then again at line 42:

"In practice, it is desirable that the transformer 82,83 shall be adapted to work between circuits of high impedance, and that the resistances 80 and 84 shall be large. With the thermionic detectors which I have commonly used; I find that the resistances 80 and 84 may be of the order of 100,000 ohms."

I next call your attention to De Forest patent No. 1,375,447, Item 24, and I might say in connection with this patent that although it does not appear on its face the plaintiffs in this action acquired rights under these De Forest patents, and this is the patent for the so-called Cascade or Seriatim amplification of audions. I might also say that this patent was secured after an interference proceeding in the Patent Office.

The Court: Who were parties to it? 770

Mr. Darby: Langmuir, of the General Electric Company, and Dr. De Forest. Dr. De Forest prevailed, establishing the application of the invention, in September, 1912. I think reference has been made either in opening by the plaintiffs or some one of the telephone engineers made the statement on the witness stand, that Dr. De Forest brought the audion to the Western Electric Company and Dr. Arnold took the audion and developed it, increased the vacuum of it, and these circuit experiments were going on at the same time, which gave rise to this series of patents, all of which was preparation work for establishing trans-continental telephony, and it was on the cascade audion amplifier shown in this patent that was exhibited to the engineers of the Western Electric Company by Dr. De Forest in October, 1912, and I do not believe it is necessary to give any expert testimony in connection with that. I want the patent before the Court because it shows the broad idea of cascade amplifica-

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tion, and various means of coupling them, and I might merely call the witness's attention to Fig. 1, compared with Fig. 2. There appears to be 2 coils marked 16 in Fig. 2, and there is only one coil, marked 13, in Fig. 1. Now what is the difference electrically between that arrangement?

The Witness: In coil 16 the two windings were the same, or the ratio is 1 to 1, there would be no difference in them, because it is a 1 to 1 transformer. However, with Fig. 2 we can change the ratio so as to get a voltage step-up between the stages of amplification.

773

Q. And in the art where there is a one-to-one transformation, that instrumentality or transformer is known as an auto-transformer, is it not? A. Yes.

774

Mr. Darby: Does your Honor understand that an auto-transformer has only one coil there? It is merely cutting across

The Witness: You can have more than one-to-one, for instance here, you step down to have two windings act as one. I mean one acts as two.

Q. The one acts as two, that is what you mean? A. Yes.

Q. Referring to Fig. 5 of the patent, I notice in the output circuit of the last two tubes of the cascade amplifiers, that there are a number of loudspeaking devices, 91, 92, 93, 94, 95 and 96 respectively connected in series; are each one

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of those loudspeaking or telephone-speaking devices, resistance devices? A. No, they are what would be called impedance devices, characterized different from resistance; resistance being only effective for direct current. For alternating current, impedance or reactance devices are employed, and these devices will have both resistance and reactance.

Q. If they are connected in series as there shown, their impedance effect is additive, is it not? A. It is increased. If the three were of the same impedance, the impedance, as far as the tube would be looking into it as much as three times to one.

Q. It is additive; it is the sum total of all three? A. Yes.

The Court: Is that the same thing as cumulative?

Mr. Darby: Yes, sir.

Mr. Ashton: Before you take up the next patent, Mr. Darby, I would like to state that my information is that the audion amplifier which De Forest brought to the Telephone Company in October, 1912, was not a cascade amplifier, but a single tube.

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Mr. Darby: I fought through two suits on it so far and one is going to the Supreme Court, and I hold my ground that it was a cascade amplifier according to Mr. Richards and Dr. Arnold himself, before he died, testified to that effect and I will be glad to check it with you.

Q. Now, Weagant Patent No. 1,384,108, item 26 in Fig. 1 of that patent, there is shown the

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additional resistance 15 in the output circuit, is there not? A. Yes.

The Court: Fig. 1?

Mr. Darby: Yes, your Honor.

The Court: All right.

Q. Would that resistance have the inherent effect of straightening out the cascade curve of the tube? A. Yes, sir.

779 By the Court:

Q. Is No. 14 the condenser there? A. Yes, 14 is the condenser.

Q. Does that current get to 16 from the output? A. It divides between 16 and 15, those two being in parallel.

Mr. Darby: You see, your Honor, in the output circuit of a vacuum tube, there is both direct current and alternating current. You have to have a path of travel for both; a path of travel for the alternating current is through the condenser, shunting around resistance 15 to the condensers for the reactance, depending on their value and impedance for alternating current, is that correct?

The Witness: Yes.

Mr. Darby: The characteristic wave is more concerned with the direct current and that is the reason why in the patent in suit, we have under consideration, for example,—it is concerned only with direct current because there is no condenser by-pass shown. Therefore, with

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reference to the pertinency of the Weagant patent, we can completely forget the condensers and refer only to the direct current path.

Q. Finally on this patent, if you will turn to Hewitt Patent No. 1,393,699, item 28, I call your attention to Fig. 2, which shows the three-electrode audion type of structure. Is there resistance there included in the plate circuit, in addition to its normal load? A. Yes, resistances 19 and 20, in series with the translating device 18.

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Q. They are both made adjustable so that any desired value thereof may be had? A. They are.

Q. Now, we will take up the Arnold Patent 1,403,475, referred to as resistance capacity coupling patent and the patents to which reference will be made are:

Arnold Patent No. 1,129,942 (tab No. 10).

Nichols Patent No. 1,257,381 (tab No. 783
18).

De Forest Patent No. 1,377,405 (tab No. 25). (This patent was withdrawn; see page 252.)

Arnold Patent No. 1,398,665 (tab No. 26).

If your Honor will turn to the Arnold Patent 1,403,475, I will identify the subject matter of it to your Honor. Claims 8, 9 and 10 are involved in the suit. Claims 8 and 9 cover the resistance 25 and the condenser 26 interposed between the plate electrode 10 of one tube and

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grid electrode unnumbered of the next tube 31. That is the resistance coupling between those two tubes.

The Court: You say that the grid electrode is unnumbered?

Mr. Darby: Yes, that is unnumbered. Claims 8 and 9 cover the resistance 25 and the condenser 26 connected in that arrangement; and claim 10 brings in combination with that of resistance 29 as well. Therefore if you will turn to Arnold 1,129,942 (tab No. 10) and refer to Fig.—by the way, have you made a simplified drawing of Fig. 6 of this patent?

The Witness: I have.

Mr. Darby: I offer the simplified drawing in evidence.

(Marked Defendant's Exhibit H.)

The Court: There are only two tubes in the one I have.

(Copy of Exhibit H submitted to the Court.)

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Q. Briefly describe the arrangement shown in Fig. 6 of the patent, referring both to the patent and your simplified drawing in connection with it. A. The output from the first tube on the left, plate No. 4, is superimposed across reactance Fig. 17, which is included in the plate circuit between filaments 5 and 4. The alternating current variations appearing between plate 4 and filament 5 are superimposed across the reactance 17. The voltage thus occurring between the ends of the terminal 17 are transferred by means of series condenser 18 and the common filament connection between the two

tubes across the resistance 14, which also includes the grid number 3 of the second tube. The C battery, not marked, between the condenser 18 and 3 grid of the second tube furnishes the necessary negative bias of this combination. The only essential difference between this arrangement and that shown by the patent in suit No. 1,403,475 is in the substitution of a resistance, No. 25 by the reactance 17 in Patent No. 1,129,942.

Q. Referring to the single sheet of drawing of the Arnold patent in suit No. 1,403,475, what element in your simplified drawing Exhibit H corresponds to the reactance or resistance 25 in the patent? A. No. 17.

Q. As I understand it, in the patent, it is shown as a resistance, whereas in the simplified drawing, it is shown as an inductance, is that right? A. That is right.

Q. Has an inductance coil resistance to the flow of direct current? A. An inductance coil always has some resistance, but very little to the flow of direct current.

Q. It has reactance to the flow of alternating current, is that right? A. It is.

Q. In the circuit shown in the patent, there is a condenser 24. Now, tracing the path of current from the plate electrode 10 back to the filament in the patent, if there is both direct and alternating current in the plate circuit, it flows to and through the resistance 25, does it not? A. Yes.

Q. And then it branches; the alternating current goes through condenser 24, and the direct current going down through the choke coil 28 and battery 27, is that right? A. Correct.

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By the Court:

Q. After passing alternating current 24, where does it go? A. It returns to the filament.

By Mr. Darby:

Q. Therefore, there is both alternating current and direct current in the output circuit, in the circuit arrangement of the patent, is that right? A. That is right.

791 Q. Therefore, if an inductance is used in place of a resistance, it will have its reactance effect on the alternating current, is that right? A. That is correct.

Q. And the condenser 18, in your simplified drawing, does that correspond to the condenser 24 in the patent in suit? A. It does.

Q. I am referring to the lower left-hand condenser 18. A. Yes.

Q. What corresponds to the condenser 26 of the patent in suit? A. Condenser 26 is in the upper part of the simplified drawing.

792 Q. There is a negative grid bias battery 30 in the patent in suit; what corresponds to that in the simplified drawing? A. The battery shown between the upper condenser 18 and grid No. 3.

By the Court:

Q. Battery C you call that? A. That is battery C, yes.

By Mr. Darby:

Q. What corresponds to the resistance 29 of the patent in suit? A. Resistance 14.

Q. Referring again to this Arnold Patent 1,129,942, that we have under consideration, the vacuum tubes are all amplifier tubes, are they not? A. Yes.

Q. They are all connected in series, are they not? A. You refer to the filaments?

Q. No, I am referring to the tubes being cascaded in series. A. In Fig. 6?

Q. Yes. A. Yes.

Q. And the same is true of Fig. 7? A. In Fig. 7, the last three tubes are in parallel, as far as the grids are concerned.

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Q. In Figs. 1 and 2, they are in series? A. Yes, you are correct. They are all in series there, as well.

Q. That is what I thought. A. Yes, they are all in series.

Q. The tubes are connected in series in all of the figures, are they not? A. They are all in series, yes.

Q. What type of coupling is employed between the tubes in all the figures? A. Resistance and impedance coupling in the case of Fig. 6; all the others are resistance coupling.

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Q. No transformers are used in the coupling throughout, is that right? A. That is right.

Q. Will you turn to the Nichols Patent 1,257,381 (item No. 18); referring to Fig. 3 of this patent as illustrative, I call your attention to two vacuum tubes in the middle of the page; are they amplifier tubes as used in the circuit? A. No. 30 is an amplifier tube and I believe that No. 23 is a detector tube, as described by the text of the patent.

Q. But they are connected in series, are they not? A. Yes.

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Q. What type of coupling exists between the output or plate circuit of the first tube 30 and the input or grid circuit of the next tube 23? A. Resistance coupling 31.

Q. Is there likewise a condenser included in that connection between the resistance coupling and the input grid? A. There is.

Q. That is No. 26? A. That is No. 26.

Q. Refer now to the audions 13 and 17; what type of coupling between those audions is utilized? A. Resistance coupling. Resistance No. 31.

Q. Resistance No. 15 you mean, do you not? A. Oh, you are at the top of the page; yes, resistance 15.

Q. Referring to audions Nos. 17 and 13 connected directly with the line, what type of coupling is employed there between the two audions? A. Resistance coupling.

Q. Referring now to the bottom of the page, audions Nos. 30 and 23, what type of coupling is employed there between the audions? A. Resistance No. 31.

Q. And is there a condenser 26 likewise located between the resistance coupling and the grid? A. There is.

Mr. Darby: I will withdraw reference to De Forest Patent 1,377,405.

Q. I call your attention to Arnold Patent 1,398,665, Item No. 29. In an ordinary audion amplifier circuit, you put a telephone receiver in the output circuit on the last two of the series, is that right? A. Yes.

Q. That is, the telephone receiver or loud-

speaker device or some other reproducing devices? A. Something of that sort.

Q. If I want to add an additional stage of amplification, what do you do? A. You provide some means of coupling between the preceding stage and the next stage.

Q. That is, you take out the receiver and put a coupling connection in place of the receiver and leave that in to the input of another audion tube, is that correct? A. Correct.

Q. Has that been well known throughout the years that audion amplifiers have been used, to your knowledge? A. As far as I know, yes. 800

Q. Refer to the Arnold Patent, Item No. 29, what is the device 8 in the wiring diagram there shown? A. Device 8 is a reactance.

The Court: That is Fig. 3?

Mr. Darby: Yes, your Honor.

Q. And the device 9 is another way of illustrating a condenser, is that right? A. Correct.

Q. Now, take up the Arnold Patent 1,448,550, known as Definite Input Impedance Patent, and the art which will be referred to in connection with that is as follows: 801

Colpitts Reissue Patent 14,380, Item No. 17.

Colpitts Patent 1,129,959, Item No. 12.

Van Der Bijl Patent 1,350,752, Item No. 23.

Arnold Patent 1,398,665, Item No. 29.

Johnson Patent 1,432,863, Item No. 31.

Mr. Darby: If your Honor will turn to the patent in suit, which is tab No. F, I

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will recall to your Honor's mind that all that is necessary in order to infringe this patent is to put an impedance across the element 6, impedance in shunt to or connected across the input circuit of the audion tube. It is a resistance.

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Q. Referring to Colpitts Patent, Item No. 17, I call your attention to Fig. 3 of this patent; is there there employed a resistance connected across the input circuit and in shunt, to the input inductance? A. There is. No. 26.

Q. If the resistance connected across the input circuit to the vacuum tube is going to establish a definite input impedance, will any resistance so connected across the line establish a definite input impedance, depending on the value of the resistance used? A. It will.

Q. I also call your attention to Fig. 2. Is there an input impedance there connected across the line? A. There is, No. 14, adjustable.

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Q. I will correct you on that; it is No. 26. A. Oh, that is right, 26. No. 14 refers to the transformer. I beg your pardon. It is No. 26.

Q. And it is shown adjustable? A. It is shown adjustable.

Q. So that any desired value of resistance, within the value of the resistance coil itself may be chosen at will? A. That is correct.

Q. I call your attention to Fig. 4; is an input impedance there used across the grid electrode of two tubes connected in parallel? A. There is. Both of them are marked 26.

Q. And both of them are shown adjustable so that any desired value may be used? A. That is correct.

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By the Court:

Q. Does the adjustment of one necessarily regulate the adjustment of the other? A. Not necessarily.

Q. It would seem so from the drawing, but I do not say that it is true. A. They should be adjusted for balance in this particular circuit. The reason they have two is to balance them with regard to the two tubes.

Mr. Darby: I think what the witness has in mind is this: Due to the fact that the common lead and filament is between them, the circuit of the input, that is the input circuit of one tube extends from the grid 13A, for example, down through resistance 26 to the battery 16, and then to the filament. That is a complete circuit.

The Court: I see.

By Mr. Darby:

Q. So that you could adjust that ordinarily so as to control the input circuit of 13-A without in any way affecting the input circuit of the tube 1-B, but in the particular arrangement elsewhere in the circuit, these tubes are described as being balanced and therefore it would not be done; is that correct? A. You can make adjustments there to affect one of the tubes, but whatever adjustments you make on there,—on either one will change the definite input impedance looking in from No. 19.

Q. Now, will you look at Colpitts Patent No. 1,129,959, Item No. 12?

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Mr. Darby: This is a patent of the prior art to which I have already called your Honor's attention, and it is in connection with this patent in suit that we are now considering, that I ask your Honor to refer to claim 1 of this patent. It reads:

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"The combination with a low impedance source of varying currents and a receiver adapted to respond to such currents, of an amplifying repeater connected with said source and having an output circuit of high impedance compared to said source, and a second amplifying repeater connected between said first repeater and said receiver and having an input circuit also of high impedance, compared to said source."

Having in mind that this patent starts with the statement:

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"A well known law of electric circuits requires that the impedance of the external path in the circuit should be equal to the impedance of the internal path or source, whenever the maximum of available energy is desired."

The Court: What is the patent in suit?

Mr. Darby: Arnold Patent 1,448,550.

The Court: Let me see claim 1 of that.

Mr. Darby (Reading):

"The combination of a vacuum discharge repeater of the three-electrode type, and inductive coil conductively connected to the input electrodes of said re-

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peater, and a conductive impedance in shunt to said coil."

Q. Now, is there a conductive impedance connected across the input electrodes of the bank of audion tubes shown in Fig. 1 of this patent?

A. There is.

Q. Name it, please. A. No. 55 and No. 53.

Q. And it is described in the patent as being provided for the purpose of effecting balance? A. I believe it is.

Q. Will you now refer to Van Der Bijl Patent No. 1,350,752, Item 23, referring to Fig. 4, is there an input impedance connected across the input electrodes of the vacuum tube 2 in this circuit arrangement? A. There is, No. 10.

Q. And what is the transformer coil? A. The transformer coil, No. 17, is for the purpose of transferring the alternating current variations of microphone 15 to the grid No. 5 of tube No. 2. Included in this input, is another transformer No. 12 that superimposes upon this audio frequency current, radio frequency alternating current to No. 14, the generator—

Q. In other words, the circuit which includes one coil of the transformer 17 is the source of current to be amplified, is that right? A. That is right, one of the sources which amplifies both the audio and the radio.

Q. And the impedance 10 is connected across the input electrodes comprising the grid 5 and the filament 3, is that right? A. That is correct.

Q. This patent points out, in line 20:

"The invention provides for modulating feeble high frequency oscillations by

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impressing the currents of telephonic frequencies, together with the high frequency oscillations, on the input circuit of a thermionic amplifier; and makes use of the fact that the amplification of a thermionic amplifier of the audion type depends upon the voltage impressed upon the grid or input circuit. If the amplifying power of the tube for the high frequency oscillations is caused to vary in accordance with the variations of the electromotive force of the telephonic waves of low frequency, the desired modulation is obtained, for there will be produced a high frequency wave the envelope of which is an accurate reproduction of the telephonic wave, and this wave may then be further amplified to any required degree for effective radiation from an antenna."

That has to do with radio telephone transmission, is that right? A. Yes.

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Q. And that is the use to which the inventions of the patent in suit was put in radio messages, to Paris, Spain, Honolulu, Canal Zone, and so forth, is that correct? A. That is correct.

Q. In this particular use, they would handle high frequency as well as low frequency, is that right? A. That is correct.

Q. And the vacuum tube handles high frequency and low frequency, does it not? A. It does.

Q. So that in so far as the function of the tube is concerned, it does not make any difference whether it is radio frequency currents it is

handling or audio frequency currents? A. It does not.

Q. In other words, was my statement correct? A. As far as the function of the tube is concerned, it is only the associated circuits which determine whether or not the tube is handling radio frequency or audio frequency.

Q. In other words, if I wanted to use a vacuum tube for radio frequency purposes, I would connect in the input and output circuits, instrumentalities that were designed and built with physical and electrical characteristics capable of handling radio frequency currents, is that right? And if as here, in the defendant's apparatus, I am only going to use audio frequency currents, then the instrumentalities employed in the circuits of the audion, are of audio frequency design, is that correct? A. Yes. Of course, there are exceptions to this. There are some tubes that are better adapted for radio than audio, and vice versa. There is no universal tube.

Q. In other words, while all tubes are the same in general principle of construction, consisting of a filament or cathode, grid and plate, the physical structure of those various elements may differ in accordance with the specific purpose for which it is to be used, is that right? A. That is right.

Q. That is the reason why, in defendant's apparatus, for example, as well as in all similar equipment, tubes of different types, such as 201-A, 227, 226, 250, 280 and 281 have been built, all differing from each other in detail of construction, depending upon the particular use

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to which they are to be put? A. That is correct.

The Court: Any time you don't want to agree with Mr. Darby's testimony, just tell him so.

Mr. Darby: That is all right, he has to be cross examined on it.

The Court: That is just it, if you were to be cross examined on it, it would be better.

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Mr. Darby: I might say this, your Honor, there is really no dispute about these things, and the reason I go about it in this way, is because I want to get it in as speedily as possible.

Mr. Ashton: I think there is a great deal of dispute on a great deal of it.

The Court: If there is no dispute, all you have to do is to stipulate the adjudication of the case.

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Mr. Darby: In this connection on the Van Der Bijl patent, I will ask your Honor to mark claim 10 as well as claim 20 for future consideration. Likewise, if you would mark page 2, line 76, where this device 10 is referred to as a potentiometer, and likewise beginning at line 106 and extending down through line 123.

The Witness: Are you correct in that? Isn't that 86 that you were referring to as a potentiometer?

Mr. Darby: No, line 76.

The Witness: Oh, yes, that is correct; it is also in line 88.

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Q. There is one more patent that I will refer to. Johnson Patent, No. 1,432,863. I call your attention to Fig. 1 of this patent and to the resistance 12 connected across the line, prior to reaching the transformer 5. Does the resistance located in the line prior to reaching the resistance 5 affect the impedance in the input circuit impressed upon the grid and filament electrodes of the first audion 8?

The Court: Will you read that question? 824

(Question read.)

A. Yes, I would say that it does affect it.

Mr. Darby: If you will turn to the patent tab C, your Honor, which is the Arnold Patent No. 1,349,252, in Fig. 5, just such an arrangement is shown where through a transformer the effect of resistance is impressed upon the plate filament circuit.

The Court: That is on the output circuit; this is on the input?

Mr. Darby: That is right.

Q. Now, taking up Arnold Patent 1,465,332—

Mr. Ashton: Before you do that, I just want to remind the Court that Mr. Kendall's testimony the first day of the trial, we showed the date of the invention of this 1,448,550 patent was at least as early as March, 1914.

Mr. Darby: No, they have put in evi-

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dence tending to show that, but they have not shown it, under the well-established law necessary to carry date of invention back.

Arnold Patent 1,465,332, which is characterized as the Common Plate Supply Patent which is tab G, your Honor will recall, that the asserted invention of this patent is utilization of a single source of current for supplying of the plates to the audions. Mr. Waterman expounded at some length what great practical advantages ensue if you don't have to have separate plate battery for the audions used.

The patents that will be relied upon and utilized on this are:

Arnold Patent 1,129,942, tab No. 10.

Campbell Patent 1,227,113, tab No. 15.

Alexanderson 1,340,101, tab No. 21.

If your Honor will turn to tab 10, the Arnold patent first referred to—

Mr. Ashton: I call your Honor's attention to the fact that the Campbell patent has not been cited against this patent.

Mr. Darby: Yes, it has been cited. These were all cited; they were all cited in the bill of particulars. Whether or not it was cited against this patent is wholly immaterial.

Q. Turn your attention to Fig. 6 in this patent—

The Court: That is tab 10!

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Mr. Darby: Yes, your Honor.

Q. Referring to Fig. 6, how many batteries are employed for supplying the plate electrodes of the various tubes there shown? A. There is one battery, No. 13.

Q. And how many plates? A. There are three plate circuits furnished from this one battery.

Q. In Fig. 6? A. In Fig. 6.

Q. And in Fig. 7, how many batteries are employed for supplying the space current to the plate electrode? A. There is one battery supplying the five tubes. 830

Q. And is any mechanism employed for smoothing out the current? That is, is there an inductance or a choke coil connected between—
A. In Fig. 6 there are chokes 17 in each instance.

Q. Are the chokes shunted by condensers? A. In the first two tubes they are shunted by condensers No. 18. I have a simplified circuit drawing of that if you wish to use it.

Mr. Darby: I offer in evidence simplified circuit that the witness has drawn of Arnold Patent No. 1,129,942 as to Fig. 6.
(Marked Defendant's Exhibit L.)

Q. Have you used the same reference characters in your simplified drawing that are used in the drawing of the patent? A. Yes, I believe so. The same numbers appear.

Mr. Darby: I call your Honor's attention to the statement contained on page 3 of the patent, line 5:

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"Fig. 5 shows a simplification of the system illustrated in Fig. 4, in that a common battery 12 furnishes current to all the filaments, said filaments being connected in series with the battery, and a common battery 13 serves for all of the plates."

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Q. I call your attention to Campbell Patent 1,227,113, Item No. 15; will you please briefly point out what pertinency the disclosure of this patent has to the subject matter under consideration? A. Campbell's patent refers to transmitting certain frequencies or bands of frequencies without attenuation, while attenuating adjoining or nearby frequencies very highly, that such frequency being undesired in the type of device in this case which is telephone connected to a repeater.

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Mr. Darby: I will ask your Honor, if you will just mark for consideration at your convenience, beginning on page 1, line 17 to and including the end of the sentence at the top of the second column.

The Court: Why don't you have this witness expound it rather than have me look at it at my convenience?

Mr. Darby: Very well, your Honor.

Q. Will you explain what is meant by the subject matter, or expound the subject matter contained between lines 17 and 48? A. The idea is by holding certain relations between the elements that go to make up a network, so that all the phenomena of resonance and anti-resonance,

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—by “resonance” meaning an inductance and capacity in series; and by anti-resonance, an inductance and capacity in shunt, so formed and arranged that they will pass certain pre-arranged frequencies and will reject certain unwanted frequencies. This is done in a number of different ways. As a matter of fact the filter theory as applied to telephone lines, is an extremely complicated phenomenon.

The Court: That is what I thought. That is why Mr. Darby passed it along to me to read it at my convenience.

836

The Witness: I do not think it is really pertinent to go into the full theory, because we would be talking here all next week if we did.

Q. Could it be summed up with this statement— A. A simple statement would be in this case, by means of a choke we hold back alternating current frequency, and by means of a condenser we by-pass them in the direction that we wish them to go. We keep them out of one portion of the circuit and pass them into another.

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Q. Is this principle utilized and has it been utilized for a great many years, in order to smooth out a current source so as to make it constant in its supply? A. Yes, especially in power supply systems.

Q. The last patent I refer you to on this subject matter here is Alexanderson Patent 1,340,101, Item 21. Referring to the plate circuits of each of the audions there shown, what is the source of space currents for the plates? A. Generator No. 1, alternating current generator.

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Q. 1 generator supplies the plate current to all the tubes, does it? A. Yes.

Q. Finally taking up the last one—

The Court: Suppose we take that up next Tuesday.

(Adjourned to February 13th, 1934;
10:30 a. m.)

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February 13, 1934.
10:30 A. M.

Q. We will complete our consideration of the art relative to the patents in suit, by considering Arnold Patent No. 1,520,994, tab H. In connection with this patent, will you turn first to Von Lieben, tab No. 6, Patent No. 1,038,910.

Mr. Ashton: Do you want to state first, Mr. Darby, which ones you are going to rely upon?

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Mr. Darby: I will. The remainder of the patents relied upon in connection with this disclosure are:

Pierce No. 1,127,371, tab No. 9.

Colpitts No. 1,137,384, tab No. 13.

Kendall No. 1,330,470, tab No. 20.

Van Der Bijl No. 1,350,752, tab No. 23.

Johnson Patent No. 1,432,863, tab No. 31.

Arnold Patent in suit, 1,448,550, tab F.

Q. Now, referring to tab No. 6, the Von Lieben & Reisz patent, will you please briefly describe

what is there shown that is pertinent to this patent in suit? A. In Fig. 3, there is a potentiometer marked C for dividing voltage across the filament to bias the control element H. The same arrangement as shown in Fig. 2 with similar lettering.

Q. In this particular arrangement, the potentiometer is not connected across the input circuit, is it? A. No, it merely shows the use of the potentiometer for dividing voltages.

Q. In connection with vacuum tubes of the audion type? A. Yes, sir. 842

Mr. Ashton: Did you say the audion type, Mr. Darby?

Mr. Darby: I did say it. If there is anything wrong with it, will you let me look at it? Yes. Audion type.

Q. Now, turn to Pierce patent, tab No. 19; will you please similarly point out what is there shown relative to this patent we have under consideration? A. In Fig. 2 a potentiometer, 843 62, is shown across battery 61, for dividing the voltage of battery 61, the bias or grid No. 13 of the audion type tube.

Q. Between what electrodes is the potentiometer connected? A. The potentiometer is connected between the filament and the grid, provided the relay contact No. 54 is made. There is a relay there for opening and closing, and that relay, to make a contact on the back side to the potentiometer is in the circuit, that is not exactly in between, because the secondary of 23 is in series with it.

Q. You say the secondary of 23 is— A. Trans-

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former 23 is in series with the potentiometer. The potentiometer and the secondary of the transformer is between the filament No. 14 and grid No. 13. You can follow that circuit out from 14 through conductor 26, through the secondary of the transformer 23, through the top conductor No. 50, No. 55, contact No. 54 of the relay, contact No. 63 of the potentiometer through conductor No. 56 to the grid No. 13.

Q. And is the connection to the potentiometer illustrated as adjustable, so that its effect may be varied at will. A. Yes, it is adjustable. Contact 63 will adjust the potential of battery 61 to get any desired potential on grid No. 13.

Q. Now, will you refer to Colpitts Patent No. 1,137,384, tab No. 13. Refer first to Fig. 2. Will you please trace the input circuit of the audion No. 1? A. The input transformer of audion No. 1 is No. 15,—marked No. 15 on the drawing, primary No. 19, secondary No. 14. Shunted across this transformer is an adjustable resistance No. 14.

846 Q. No. A. No. 26; also a battery No. 16. The contact on the adjustable resistance can be adjusted to put any resistance across the secondary of transformer No. 15. Connected to the contact is the grid 13 of the tube, and the input circuit is between the filament of the tube to the grid.

Q. And is the resistance 26 connected—

The Court: Just trace that input circuit.

Q. Start from the grid and trace the input circuit. A. From 13 to contact 26, it is in paral-

lel with it through the secondary of the transformer No. 14, through the condenser not marked to the filament No. 7.

Q. And the battery 16 is likewise in that input circuit, is it not? A. Yes, the battery 16 and the adjustable resistance 26 is in shunt to the input circuit.

Q. Is the adjustable resistance 26 as there shown, a potentiometer? A. No, it is not.

Q. Now, will you refer to Fig. 3? A. Yes.

Q. Before taking up consideration of Fig. 3, 848 will you just explain in a few words, in what respect the arrangement shown in Fig. 2 differs from a potentiometer? A. It differs from a potentiometer inasmuch as that one end of the resistance is free and is not connected across any device. With the top end of that potentiometer connected to the wire immediately above it and connection between No. 26 and No. 15 to the transformer,—secondary 14 rather, removed, it would be a potentiometer arrangement.

Q. Now, referring specifically to Fig. 3, I notice that the resistance 26 is completely connected across the input circuit. Is that correct? 849

A. That is correct.

Q. In other words one of the deficiencies that you mentioned with respect to the showing of Fig. 2, to make it a potentiometer, has been there supplied; is that right? A. Yes.

Q. The resistance 26 is not shown as variable, is it? A. No.

Q. And there is no adjustable output from the grid electrode to the resistance 26, is there? A. No.

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Q. Is the arrangement shown in Fig. 3 a potentiometer? A. No.

Q. Referring now to Fig. 4, is the arrangement there shown with respect to the resistance 26 a duplication of the arrangement shown in Fig. 2, as applied to two tubes in parallel? A. Yes, as far as the input to the tubes is concerned—the input circuit to the grids.

851 Q. Is the arrangement shown in Fig. 4, insofar as the input circuit resistance is concerned, a potentiometer arrangement? A. No.

Q. Will you now please refer to Kendall patent No. 1,330,471, tab No. 20. I call your attention to Fig. 4 of the patent and the last tab of the series. Will you please trace the input circuit of the last tube, starting from the grid electrode 87? A. Starting from the grid electrode 87 through the C bias battery 93 to the contact of the potentiometer 84, which is in shunt across the secondary 83—the transformer itself not being numbered. The circuit divides at the contact of the potentiometer 84, part of it going through the secondary 83, the remainder through the lower half of the potentiometer to the filament 86.

852 Q. Insofar as the use of a potentiometer in the input circuit of a vacuum tube is concerned, what difference exists between the disclosure of the Kendall patent and the disclosure of the Arnold patent in suit No. 1,520,994, tab H? A. None whatever.

Q. They are identical? A. They are identical.

Mr. Ashton: I point out, your Honor, that is the patent which the witness Ken-

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dall testified he learned the invention of from Dr. Arnold.

Mr. Darby: Your Honor will understand I am deferring my argument until later.

Q. Will you now refer to Van Der Bijl Patent 1,350,752, tab No. 23. Referring to Fig. 4, will you there trace the input circuit from the grid to the filament? A. From grid 5, through the secondary 11 of transformer 12, to the contact or movable contact point of potentiometer 10. The circuit there divides, a portion thereof going through the secondary of transformer 17, the remainder through the lower half of potentiometer 10 to the negative pole of the bias battery 7; thence on the positive side of bias 7 to the filament 3.

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Q. What is the source of currents to be amplified in this arrangement? A. The source of currents to be amplified is a combination of voice frequencies or audio frequencies from transmitter 15 and the radio frequency generator 14. The two are combined on grid 5 to perform what is called modulation in radio frequency transmission.

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Q. Insofar as the inclusion of a potentiometer connected across the input electrodes of a vacuum tube is concerned, in what respect if any does the disclosure of this patent differ from that of the patent in suit, tab H? A. It differs in no respect from the patent in suit. It is placed there for the purpose of regulating the volume of the audio frequency input to the tube.

Q. What is the purpose of the use of the

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potentiometer in the input circuit of the patent in suit? A. It is the same thing.

Mr. Darby: I will ask your Honor to mark the passage beginning at line 20, the first page of this, patent. I would like also to call your Honor's attention to the illustrative claims of this patent, as Claims 10 and 20.

Q. Will you now refer to the Arnold patent
857 in suit, tab F, Patent No. 1,448,550, and I call
your attention to the resistance 6 included in
the input circuit of that patent. Is that a po-
tentiometer? A. No, that is not a potentiometer.

Q. What would be necessary if it was desired
to use that as a potentiometer? A. It would be
necessary to place contacts along the resistance
to which the grid would be connected, instead
of to the upper end of the resistance as shown.

Q. In other words, am I correct in under-
standing you that if the connection from the
positive end of the biasing battery 4 was dis-
connected from the top of the resistance 6 and
made slid able along it, that would make that a
potentiometer? A. It would.

Q. How long have you been familiar with the
use of a potentiometer in the vacuum tube art?
A. Well, that is difficult to say. I cannot place it.

Q. But is a potentiometer something that you
have just recently become familiar with? A.
No. In connection with vacuum tubes the first
use of a potentiometer was for dividing the
voltage of the batteries, as shown in some of
the patents we have cited. It has long been used
for regulating volume, but I cannot place the
date.

Q. As an instrumentality in the electrical art was it well known prior to 1915? A. Well known as a divider of voltages.

Q. Will you now please refer to Johnson patent No. 1,432,863, tab No. 31. I call your attention to the arrangement shown in Fig. 1, the resistance 12. Is that a potentiometer there shown? A. No.

Q. Is its effect on the input circuit of the audion tube 9 relayed through the transformer 5? A. Yes.

Q. What would be necessary to make the resistance 12 a potentiometer? A. We would connect the lowest side to the line 3 and disconnect line 3 from the lowest side of the primary 4 of transformer 5, so that the variable voltage across resistance 12 would be impressed upon the primary of transformer 5 by means of the adjustable set on the resistance.

Mr. Ashton: Mr. Darby, I assume that that you are not relying upon or putting in evidence the following patents, which have not been mentioned; namely, Langmuir 1,313,094; De Forest 1,348,157 and Reisz 1,418,022?

Mr. Darby: I did not intentionally overlook any. If you will give me a minute I will answer your question, Mr. Ashton.

Mr. Darby: That is correct, Mr. Ashton, as to two of them. I am not offering in evidence Langmuir patent 1,313,094, tab No. 19; I am not offering in evidence Reisz 1,418,022, tab No. 30. I am not offering in evidence De Forest 1,348,157, tab No. 22.

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Mr. Ashton: All three of them?

Mr. Darby: All three of them.

Mr. Ashton: I would like to ask Mr. Darby if he is relying on any of these patents for double-patenting?

Mr. Darby: Yes, as pleaded. In other words, it will take some time. There is a mass of these patents, and they are so overlapping it will take some time to dig them out for you; but I have furnished a bill of particulars in the case, in which I have classified them.

863

Mr. Ashton: I believe Mr. Darby has in mind the one he spoke to me about in his office. I think it was Patent No. 1,448,550 as against the patent in suit No. 1,520,994.

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Mr. Darby: I claim that Arnold Patent No. 1,349,252 is invalid because of double patenting, in view of Arnold Patent 1,329,283, and that Arnold Patent No. 1,448,550 is invalid in view of double patenting of the same Arnold Patent 1,329,283. I think that is all.

Cross Examination by Mr. Ashton:

Mr. Ashton: Your Honor understands that we noted our objection the other day to the use of any of these patents except those pleaded in the bill of particulars and we do not wish it to be taken that in the cross examination on these patents that we are foreclosed from our position.

Mr. Darby: You will note, Mr. Ashton,

that three of the patents to which you objected have been withdrawn.

Q. Did you once work, Mr. Cloud, for one of the telephone companies? A. Yes, I worked for the South Western Bell Company and for the Illinois Bell.

Q. About when was that? A. I also worked for the Western Electric Company in 1905. Prior to 1905, I worked for the Western Electric Company. In about,—I don't remember the exact date, in 1906, I went to work for the South Western Bell Telephone. In April, 1912, I went to work for the Illinois Bell, which was then the Chicago Telephone Company.

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Q. Just roughly, what was the nature of your work for these companies? A. With the Western Electric Company, I was erecting and installing switchboards, doing circuit work and power installations.

With the South Western Bell, I was chief switchboard man, wire chief, inspector of the Inspection Division of the State of Texas.

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Q. You were in the operating department? A. I was in the operating department. I was plant engineer for Northeast Texas.

Q. In charge of the handling of the plant? A. Of all switchboard and of all plants.

Q. I believe you testified that your work has been principally in connection with talking motion pictures since 1928, is that correct? A. That is correct.

Q. With what company were you connected in 1928? A. In 1928, I was doing work in spare time only with Mr. Harley L. Clark, who later became president of Fox, in connection with

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what is known as the Orchestra Phone Company. I was merely consultant.

Q. Did that company supply talking motion pictures? A. It supplied not talking motion pictures, but incidental music for picture theatres.

Q. What other talking motion picture connections have you had since that time? A. Since that time, I have been with Jenkins & Adair.

Q. What was their business? A. They made recording equipment for talking pictures—recording cameras and amplifiers.

Q. Did you have something to do with the amplifiers? A. Yes, I had something to do with the amplifiers, although my particular feature was not exactly talking pictures at that time; it was with a special recording device not being used in talking pictures.

Q. What was your next connection? A. My next connection was with E. N. Zelony in connection with talking pictures and amplifying equipment.

870 Q. Who was Mr. Zelony? A. Mr. Zelony represents Jenkins & Adair, and he is also sales representative of the Amatran-American Transformer Company.

Q. Are you an officer of that company? A. Yes, I am an officer of that company.

Mr. Darby: Which company do you mean?

The Witness: I am chief engineer of E. N. Zelony.

Q. Chief engineer? A. Yes.

Q. Does that company supply amplifiers for

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talking motion pictures? A. Yes, they have supplied amplifiers for talking motion pictures. The amplifiers in question, were sold through them, I understand, although at that time I was not with them.

Q. What time was that? A. Prior to 1933.

Q. When did you come with them? A. The first part of 1933—a little more than a year ago—about a year ago.

Q. What was the business of the company at that time? A. It was the same. It is a sales organization and an engineering organization.

Q. Does it make any amplifiers itself? A. Yes, we have made amplifiers.

Q. Just tell me what amplifiers it makes and what they are sold for.

Mr. Darby: Just a minute, I do not think that is proper cross examination. Mr. Ashton apparently is laying the foundation for another suit.

Mr. Ashton: Nothing of the kind, your Honor. This witness testified that he is now with a company that is making amplifiers that probably use the inventions of these patents. It may be that we might want to sue them. I want to know exactly what his connection is with this talking motion picture art, in particular with amplifiers, which he has been testifying about here.

The Court: In other words, you are examining him on his qualifications?

Mr. Ashton: That is included, your Honor.

Mr. Darby: If he attacks his qualifica-

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tions, that is one thing, but I ask that the nature of his questions be carefully scrutinized, to see whether it has a bearing on the question. Will you please read the question, Mr. Stenographer?

(Question read.)

Mr. Ashton: He testified that he was chief engineer of this concern, Mr. Darby, making these amplifiers.

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The Court: Is there any way by which you can make your question a little more pointed, in the light of the fact that the witness is engaged in the manufacture and sale of amplifiers that employ such amplifiers as are here in suit?

Q. Did you make amplifiers such as here in suit by Zelony? A. Yes.

Q. Then you know what those amplifiers contain? A. Yes.

Q. Do they contain a negative grid bias?

876

Mr. Darby: I object to that, if your Honor please. I do not believe that goes to his qualifications at all.

The Court: He has identified the negative grid bias in several of these patents and explained its function. I cannot probe the mind of examining counsel, but on the surface of things, it would seem to me to be a competent question, wouldn't it?

Mr. Darby: I submit respectfully that it would not. How can a question, no matter how it is answered, of that character test the qualifications of this man?

The Court: Simply in relation to his

familiarity with the device and the opportunity that he had to observe it, probably.

Mr. Darby: Any question asked of him to show that he is familiar with the device, is proper, of course; any question directed to finding out what experience he had with a device operating with a negative bias, is proper; but the mere question, did the device which was manufactured and sold by your company contain a negative bias, I submit does not go to the qualifications of the witness at all.

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Mr. Ashton: I think it is perfectly clear that this witness has come here as an impartial witness, he is engaged in designing and selling—

The Court: Impartial?

Mr. Ashton: Yes, to tell the Court.

The Court: Yes, but experts are not impartial, as a rule.

Mr. Ashton: I think it bears directly on his partiality to show that he is interested to have these patents knocked out.

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The Court: That is his purpose in testifying, of course. I do not believe anybody is misled by the "impartiality" argument.

Mr. Ashton: It is perfectly proper, in view of that fact, it seems to me.

The Court: Let us straighten the matter out once and for all, by having you state the purpose of your question.

Mr. Ashton: The question bears not only on his qualifications, but also on the question of whether or not he is directly

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interested in business, so far as these patients are concerned.

The Court: With respect to the latter half, I am not interested, and I will sustain the objection. If your purpose is to ascertain any facts of that nature, I will have to ask you to re-form your question, please. Then confine yourself to the witness' qualifications as an expert.

881 Q. Will you state whether you designed these amplifiers entirely yourself or whether other people assisted you? A. In some cases entirely myself; in other cases other people have assisted me.

Q. Those amplifiers are now being sold for talking picture purposes? A. We have only made one amplifier for talking picture purposes.

Q. Have you sold that to the defendant? A. No.

Q. Has it been used? A. Not commercially.

Q. Merely for demonstrating purposes? A.

882 Mereiy for demonstrating purposes.

Q. And does your company have any connection with the defendant in this case? A. No, not as a company. E. N. Zelony & Company, Inc., is a new company and it has only been in existence about six months, and my company has not sold any equipment to the defendant since it has been organized.

Q. Have you had any connection with the defendant, other than working on this case? A. None whatever.

Q. Do you have an office at the same address as the defendant? A. Next door to them.

Q. Did you ever submit an amplifier to the

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Fox Film Company for the Fox Corporation?
 A. We never submitted an amplifier to Fox; we have brought amplifiers to the Fox organization for test.

Q. What was the purpose of that? A. The purpose of that was to construct an amplifier that would not infringe the patents of the plaintiff.

Q. The patents of the plaintiffs here in suit?
 A. The patents of the plaintiffs here in suit.

Q. What was the result of those tests; was the amplifier admitted?

Mr. Darby: I object.

The Court: Objection sustained and exception.

Q. You testified, Mr. Cloud, that you were patentee of a number of patents, did you not?
 A. Yes.

Q. And you stated that some of those patents had to do with things similar to the subject matter here involved? A. I did.

Q. You were the patentee of this patent 1,907,741, of May 9, 1933, which I note states that one-half has been assigned to Emanuel N. Zelony. A. I am.

Q. Does this patent disclose a negative grid bias? A. Not in the sense of the Lowenstein patent.

Q. It was a patent to get around the Lowenstein invention if possible, was it not? A. It was.

Q. Did you submit that to the Fox Company?

Mr. Darby: I object.

The Court: What is the purpose of that?

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Mr. Ashton: The purpose of this, your Honor, is here we have a patentee trying to escape the Lowenstein invention as late as 1930 and I wish to point out several features and ask him about this patent, that has a direct bearing on the Lowenstein invention.

The Court: I can understand that, but I do not understand what the connection of the Fox Company has to do with it.

887 Mr. Ashton: I want to know if they adopted it after he submitted it.

The Court: Why don't you subpoena them and ask them?

Mr. Ashton: Very well.

Q. Does this patent not admit at page 3, line 50, that the potential of the grid is constantly varied?

Mr. Darby: I object, if your Honor please, irrelevant and immaterial.

888 The Court: Is not that the basic theory of all these patents, that the potential and the grid vary and necessarily so?

Mr. Ashton: Under the arrangement which he has in his patent, your Honor, the potential of the grid, which he seeks to maintain there, is a constantly varying potential, being the potential of the Lowenstein patent which is designed as a definite negative potential, that is, without the signal. What is confusing your Honor, is the signal which comes in on that input circuit. The Lowenstein patent goes to putting a negative bias on the grid which is a definite bias, until such

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time as the signal comes in. In this particular patent, this device which the patentee uses permits the grid to become positive when certain signals are impressed upon the grid, and it is that which he is seeking to overcome. He is trying to compensate for that without using the Lowenstein invention. Now, the prior art in this case which Mr. Darby is relying upon, shows some of the same instrumentalities which Mr. Cloud uses in this patent and it has a direct bearing on the inventions of the prior art also.

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The Court: If you were suing on the Cloud patent, I could see the purpose of it, but you are not.

Mr. Ashton: This patent not only refers to the desirability of having a negative bias of a grid such as Lowenstein disclosed, but shows that this expert was trying to get around that invention as late as 1930.

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The Court: He has told you that. He told you that he sought to accomplish the same object Lowenstein accomplished, but in a different way. Isn't that what his testimony is?

Mr. Ashton: I believe he has said that. I want to refer to the particular parts of the patent.

The Court: That is the basic fact. Why corroborate it?

Mr. Ashton: I will offer the patent in evidence later, your Honor.

Q. I wish you would state whether these patents which I read to you are also your patents:

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Patent No. 1,907,741. A. I have no copy of that. I have a copy in my case, I believe. That is, yes.

Q. Patent No. 1,831,589 also? A. Yes.

Q. Patent No. 1,767,277? A. Yes.

Q. Patent No. 1,827,970? A. Yes.

Q. Patent No. 1,864,890? A. Yes.

Q. And No. 1,751,978? A. Yes.

893 Q. It is true, is it not, Mr. Cloud, that it is particularly important where large undistorted output is needed for talking motion pictures and public address systems, to use the invention of the Lowenstein patent? A. No.

Q. It is not? It is common practice to use it, is it not? A. It is common practice, but it is not essential.

Q. That is not what I asked you. A. It is common practice, yes.

Q. Is it also important in public addresses and talking motion pictures to reproduce substantially the piano range of frequency? A. Yes.

Q. Or even greater? A. Even greater.

894 Q. I believe you testified, did you not, that your first connection with vacuum tubes was around 1915, was it, or later? A. My first connection with vacuum tubes was—I first became interested in 1912 on hearing a lecture by Professor Millikan, and soon after that, I commenced to experiment with vacuum tubes, circuits, and so on. About 1915 or 1916, I think was the first time that I really seriously experimented with wireless.

Q. I wish you would please select the reference which you think is the best reference against the Lowenstein patent.

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Mr. Darby: I object to that question, if your Honor please. I don't think that is proper practice in this court to require an expert to make such a selection.

The Court: I have heard it done frequently.

Mr. Darby: I have heard it done both ways.

The Court: I think it is quite helpful to the Court to have an expert indicate patents which most nearly approximate the patent in suit.

896

Mr. Darby: It will perhaps be necessary for the witness to review each one of these patents before he answers the question, and that may take some time.

The Witness: I can answer this one.

The Court: I do not think he will improvise his theory now.

Mr. Darby: No.

The Witness: I believe De Forest Patent No. 841,387, tab No. 1.

897

Q. Is it true that the only two batteries in this patent whose polarities are not given are B¹¹ in Fig. 2 and B¹¹¹ in Fig. 4? A. Yes, I believe that is so.

The Court: I would like to have that question read again, please.

(Question read.)

Q. Does not the battery B¹¹¹ furnish current in Fig. 4 for the microphone T¹¹¹? A. It is not a microphone. Oh, in Fig. 4?

898

Raymond T. Cloud—For Defendant—Cross.

Q. Yes. A. Yes, the battery B^{11} furnishes power for the microphone T^{11} .

Q. Is it not true that in some of the figures of the patent the long line battery symbol indicates plus and in others it indicates minus? A. That is true.

Q. Do you know whether it was common at this time in 1906 to have sensitizing batteries for detectors? A. Yes. In all probability it was. I think it was common. That was before I had any direct experience with it, necessarily.

Q. If sensitizing current was to pass through T^{11} , would not the battery B^{11} have to be poled positively to the grid D in Fig. 2? A. The tube in Fig. 2 is not a detector tube.

Q. Isn't T^{11} a detector? A. T^{11} is a detector, yes. You are referring to sensitizing batteries for detectors.

Q. Yes, B^{11} . A. No, that was not always the case for the crystal detectors and such types. Sometimes the sensitizing batteries were used and sometimes they were not.

900 Q. You have already testified it was customary to use them. A. I misunderstood your question. I thought you were referring to vacuum tubes.

Q. Would you like to have the question read to you again? A. Yes.

(The question was read as follows):

Q. If sensitizing current was to pass through T^{11} , would not the battery B^{11} have to be poled positively to the grid D in Fig. 2? A. That is correct.

Q. Will you refer for a moment to the Von

Raymond T. Cloud—For Defendant—Cross.

Lieben patent 1,038,910. Did not the Von Lieben tube operate by virtue of ionization of gas in the bulb? A. At this time it was not fully understood, those pure electronic discharges. Even Lowenstein speaks of ionization in his tube.

Q. Can you answer the question? A. I don't know. It depends upon how far the tube was evacuated.

Q. You were not familiar with Von Lieben tubes at that time? A. No, I never saw a Von Lieben tube.

Q. Do you know whether the Von Lieben tube as it was constructed at that time would work if the element which has been referred to as the control element H were not positive?

The Court: Is that H in Fig. 1?

Mr. Ashton: Yes, in all the figures.

A. If the tube was sufficiently evacuated it would work.

Q. You do not know whether they were sufficiently evacuated or not? A. I do not know.

Q. You have no opinion as to whether they were or not? A. He has disclosed nothing in his patent to show whether they were or were not.

Mr. Ashton: I wish to point out, your Honor, the reference at the bottom of page 6 of Judge Winslow's opinion regarding the Von Lieben patent, where he states that the Von Lieben and Riesz patents are quite different from the Lowenstein disclosure and do not anticipate.

I also call your Honor's attention to

904 *Raymond T. Cloud—For Defendant—Cross.*

the statements of the Court of Appeals in the opinion in the Wallerstein case, beginning at page 5, with respect to this Von Lieben tube and patent. It goes on over to page 7, at about the middle.

Q. Is this not true of the Von Lieben tube: that the auxiliary electrode H constituted a partition in the tube and had necessarily to shut off the cross section of the tube? A. I believe he has shown it that way in the drawings.

905 Q. I call your attention also to page 1 of this Von Lieben patent, beginning at line 51, and ask you if that indicates anything to you as to the type of tube that the Von Lieben tube was, as to whether or not it would work if the element H were not positive? A. Yes, that shows that element H would have to be positive.

The Court: In order to do what?

The Witness: In order to operate.

The Court: As what?

The Witness: As an amplifier.

906 Q. In order for the tube to work at all it would have to be positive? A. Yes.

Q. Now, will you select the best reference with respect to the Mathes patent in suit 1,426,754? A. I believe that Arnold patent 1,129,942, is the best reference with regard to the claim that is in suit. That is tab No. 10.

Q. Are the resistances 14, Fig. 5, coupling resistances in the plate circuit? A. No. 14 is a resistance in series with the filaments.

Q. Are you sure of that? A. Well, he has numbered three resistances. Two of them are coupling resistances and one of them is a resistance in series with the filaments.

Q. Which resistance are you referring to as in series with the filaments? A. The one further to the right.

Q. Have you referred to the resistance to the left of the one marked 14? A. Yes, there are two resistances there that are coupling resistances.

Q. Do you know whether that is an error in the patent, as to marking that 14?

The Court: Which 14 are you speaking of? 908

Mr. Ashton: The one to the right.

The Court: The farthest to the right?

Mr. Ashton: At the extreme right.

The Court: In Fig. 5?

Mr. Ashton: Yes.

A. No, I do not know whether it is an error in the patent or not.

The Court: Do you mean the patent or the drawing, by your question?

Mr. Ashton: I mean the drawing, your Honor. 909

Q. Is the bias obtained by the batteries 11 in these figures?

The Court: Are you still referring to Fig. 5, or all of them?

Mr. Ashton: Most any one of them, your Honor. We will continue to refer to Fig. 5.

A. The bias is a resultant voltage of several voltages in the network.

910 *Raymond T. Cloud—For Defendant—Cross:*

Q. Will you refer to page 2 of the patent, line 109, where it states "the batteries 11 are preferably of such value as to make each of the grids 3,3 and 7 normally about 5 volts negative with respect to its adjacent filament"? A. Yes.

Q. Does that state what the function of the batteries 11 is? A. Yes, that is the function of the batteries.

Q. Is the battery 11 in Fig. 5 sometimes referred to as a bucking out battery? A. I believe so, yes.

Q. This is because it has to oppose the positive voltage of battery 13, which would otherwise be applied to the grid? A. It has to oppose that, but the drop of potential across 14 and the drop of potential across 5 also oppose it.

Q. Isn't the battery 11 chosen to make the grid 5 volts negative? A. It would make the resultant of the network 5 volts negative, yes.

Q. In Fig. 7 are not the tubes 2 all biased negatively by the battery 11 located just at the left of the middle tube? A. Yes. It is the same layout as we had in Fig. 5 with respect to that particular tube.

Q. The drawing that you had with respect to these patents of Arnold 1,129,943 and 1,129,942, Exhibit G, have you a copy of that of your own, Mr. Cloud? A. I do not believe I have.

Q. We will use this together (handing witness). On this drawing the battery E6 is at the top, and necessary to buck out the effect of the battery E9 and also supply over and above that, of the value of the battery E9, the negative voltage for the grid? A. As I stated before, it makes the voltage of the complete network negative

Raymond T. Cloud—For Defendant—Cross.

913

voltage. In other words, you could not take batteries E9 and E6 and determine the negative potential from the two batteries alone. You have to take into consideration the drop of potentials through the resistances.

Q. Now refer to Colpitts patent 1,388,450. A.

I have it.

Q. Is not the resistance 64 which you referred to the other day in the plate circuit? A. It is.

The Court: You are speaking of Fig. 2?

Mr. Ashton: Fig. 2.

914

The Witness: Starting from the positive side of generator 66, the plate circuit is through the primary of transformer 39, and it divides to the two plates of tubes 27 and 28 in parallel; thence through the space in the tubes to the filaments 33 and 34, down through the filament circuits.

By the Court:

Q. How do they get to 33 and 34? A. By means of the electron discharge.

915

Q. Do you mean across the plate; they go to the plate and then across to the filament, is that what you mean? A. Yes, you remember Mr. Waterman explained we generally spoke of them in that direction.

Q. Yes, but that is the way you get it to the filament—from the plate to the filament? A. Yes. Thence down the two sides of the filament to resistance 62, from the mid-tap point of 62 through resistance 64, and thence to the right, to the negative side of the generator 66, completing the circuit.

916 *Raymond T. Cloud—For Defendant—Cross.*

By Mr. Ashton:

Q. Did you mean to testify on Friday that this element 62 is a resistance? Is it not in fact an inductance? A. 62 can be either. It is drawn as a resistance. It can be drawn as an inductance as well. It works equally well whichever you use.

Q. Does the patent refer to it as an inductance? A. I do not know.

Q. You have not looked that up? A. I will do so.

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Q. Will you look at the bottom of page 2, the right hand column, beginning at line 126. Is it not referred to as an inductance? A. Inductance 62. I stand corrected.

Q. The current through this inductance 62 and the resistance 64 comes from the plate supply generator 66? A. It does.

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Q. I now ask you to direct your attention to the Arnold patent in suit 1,329,283, the Power Circuit Patent. Will you select for me the best reference against this patent? A. It is a little hard to decide between the patents, but I believe Arnold 1,129,943, tab No. 11.

Q. Is that your selection? A. That is my opinion.

Q. I ask you to direct your attention to the fine mesh of the grid in Fig. 1 of the patent in suit 1,329,283, and the coarse mesh grid in Fig. 3. Fig. 1 is a high voltage tube and Fig. 3 is a power tube? A. I believe that is the way that he has designated it in here.

Q. And this tube Plaintiffs' Exhibit No. 16 typifies the close mesh of Fig. 1, does it not (handing witness)? A. Yes, although Fig. 1 is exaggerated with respect to the spacing.

Q. Plaintiffs' Exhibit No. 12 with the wide mesh of the grid typifies Fig. 3, does it not (handing witness)? A. In Fig. 3 it is very difficult to say whether it is close spacing or wide spacing, as far as the grid is concerned.

Q. You do not know whether it is or not? A. I do not deny that it typifies the coarse spacing, but Fig. 3 does not show a coarse spacing.

Q. Isn't it so described in the patent? A. It is so described in the patent, but it does not show it in Fig. 3.

Q. You agree with Mr. Waterman's statements, I believe you testified on Friday, with respect to the spacing that you have just referred to, of these tubes? A. With respect to what?

Q. With respect to the spacing of the elements in the coarse and fine mesh of the grid.

Mr. Darby: I object to the question as indefinite.

The Court: Direct the witness to the statement that you mean.

Mr. Ashton: I understood him to say that he agreed with these fundamentals that Mr. Waterman referred to in his testimony, and I am just asking him if that is the case. That is as I understood his testimony when Mr. Darby started in examining him the other day, and I just wanted to make sure that that is correct.

920

By the Court:

Q. Are you able to identify the testimony of Mr. Waterman, to which the question applies?
A. Yes, sir.

921

922 *Raymond T. Cloud—For Defendant—Cross.*

Q. Then you can answer the question, can't you? A. The question asked me was relative to the effect of the spacing of the grid with regard to the filament on the output impedance of the tube. My statement was that the spacing of the grid from the filament had no direct relation to the output impedance of the tube.

By Mr. Ashton:

923 Q. That is your testimony, is it? A. I agree with Mr. Waterman in that statement.

Q. And do you agree with him as to the effect of the coarseness or fineness of the mesh of the grid? A. Oh, yes.

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Mr. Ashton: I call your Honor's attention to the fact that the date of application of the patent in suit according to the plaintiffs' position, will be taken back to the same day as the application for patent 1,129,943, which the witness has selected as the best reference against this patent in suit.

The Court: The date of application is May 28, 1914.

Mr. Ashton: Yes. The original application for the Arnold patent in suit 1,329,283 is also May 28, 1914, one application being differently numbered from the other.

Mr. Darby: I notice that Mr. Ashton has been calling attention to points that might be of assistance to your Honor as they are raised in connection with these various patents, and I think I might do likewise.

Mr. Ashton: It is helpful sometimes to

have them at the point in the record where the thing is likely to be under consideration.

Mr. Darby: Because of the fact it might be helpful I made no point when Mr. Ashton has done it, and I just want to call this to your Honor's attention, and with the same purpose in mind. One of the issues, as your Honor has undoubtedly grasped, is going to be, what is the effect of the filing date of an application which states that it is a continuation of another earlier filed application; likewise, what is the effect of the filing date of an application which is a division of an earlier filed application, where that division has been filed a number of years after the original application?

The Court: I suppose that you mean, Mr. Darby, you are going to give me authorities right in point, so it won't take any time to clear that point up?

Mr. Darby: Yes, sir; and I will give them to you now if your Honor wants them. 927

Q. Arnold patent in suit 1,349,252, the Straight Line Characteristic Patent. Will you please select your preferred reference to it? A. I have here again Arnold 1,129,943, as perhaps the best teaching. That is tab No. 11.

Q. I believe you will concede, won't you, Mr. Cloud, that it is desirable to have a straight line output from an audio amplifier? A. Oh, yes.

Q. You have stated that, haven't you, in your patent 1,907,741? A. Yes.

Q. If you will look at Fig. 4 of the Arnold

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Raymond T. Cloud—For Defendant—Cross.

patent in suit 1,349,252, it is also desirable, is it not, to have as much of the straight operating range to the left of the vertical line in that curve?

A. It is.

Q. As Mr. Waterman testified in connection with this patent? A. Yes.

Q. And it is desirable in the output of defendant's amplifiers A-41, A-36 and PA-39 to have a straight line output, is it not? A. Yes.

929

Q. Will you look at this Arnold patent 1,129,943, which you have selected. Are not the resistances 8 in both figures of this patent coupling resistances? A. They are.

Q. Do you find any disclosure as to the resistance of the tubes in this patent? A. There is no direct relation I can see of the resistance of the tube, although it speaks of a large number of audions in parallel, at page 2, starting at the top:

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"Hence for successful operation into a line of low impedance, for example, 500 ohms, a large number of audions in parallel would be required to provide in their common output line 11 an impedance approximately equal to the impedance line to which direct connection is to be made."

Q. If these tubes were high voltage tubes, might not their resistance be as high as several hundred thousand ohms—the A-C resistance? A. It is possible.

Q. Will you refer quickly to Colpitts 1,137,384. This shows a modulating tube, doesn't it?

The Court: That is tab No. 13.

A. Yes.

Q. Would not a modulating tube fail to modulate if it had a straight line output characteristic? A. It would.

Q. What is required for modulation is a curve characteristic just as in the case of a detector, isn't it? A. Yes.

Q. In other words, it is necessary to deform the outgoing current in order to impose the voice upon it, isn't it? A. Correct. That is with regard to the radio frequency.

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Q. Yes. A. Not the audio.

Q. Would not the unidentified resistance in a modulator be harmful if it was of such magnitude as to produce a straight line characteristic? A. Which resistance are you referring to, 26?

Q. The one that is not given any number; I believe the one that you have referred to as 22.

A. That resistance would not refer to the radio frequency characteristics.

Q. Is that resistance referred to or described in the specification? A. I don't believe it is.

Q. I think that is the case. A. An adjustable resistance 26, line 40—starting with line 30, where it says the arrangement is also different, in battery 16—

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Q. I asked about the one up here, the one that hasn't any number on top of Fig. 2. A. No, that is not referred to.

Q. Will you look at Kendall Patent No. 1,330,471. I believe you referred to resistance 80 in condenser 81 in Fig. 4, did you not? A. I did.

Q. Is this not merely a parallel feed resistance? A. Yes, it is a parallel feed resistance.

Q. Only in the event that it was relatively small, could it have any effect in the output cir-

934 *Raymond T. Cloud—For Defendant—Cross.*

cuit? A. You are speaking from a distortion point of view?

Q. Yes. A. Well, it has some effect, whatever its value is. It would have more use if it were low resistance.

Q. And is that parallel feed resistance always made very high, and so is entirely or without substantial effect? A. Necessarily, yes.

Q. Is the resistance 80 in the AC output circuit? A. Well, it is in the DC supply circuit.

935 Q. You haven't answered my question. A. It is a portion of the AC circuit but it is not in the AC output circuit.

Q. It is not? A. No.

Q. Is the tube 33 functioning as a detector? I call your attention to page 3, line 8.

The Court: Will you read that question?
(Question read.)

A. Yes, it is functioning as a detector.

Q. Will you now look at the De Forest Patent 1,375,447; is not in Fig. 1, No. 13, a reactance serving as a coupler whose value is not in any way indicated? A. Yes, it is an inductance reactance.

Q. The same is true of Fig. 2 whose coils are 16? A. It is transformer 16.

Q. Referring to Fig. 5, is it not true that the only loudspeakers available at the time of this application were telephones supplied with horns?

A. Yes.

Q. Did not ordinary telephones, that is commercial telephones, have very low resistance and impedance? A. Not as useful loudspeakers.

Q. Were they used in 1913 for loudspeakers? A. I rather presume they were.

Q. You don't know? A. My reason being that Lowenstein speaks of a receiver with many convolutions being necessary to work directly into the tube.

Q. You don't know yourself? A. Personally I do not know.

Q. Does the patent make any disclosure as to the impedance of either the loudspeakers or the tube? A. I don't believe that is there.

Q. Now, Weagant Patent No. 1,384,108, does the resistance 15 in Fig. 1 have any substantial effect of increasing the AC impedance of the output circuit? A. It depends entirely on the capacity of the adjustable condenser 16.

Q. Is it not stated on page 1, line 90, that the resistance 15 is not necessary to the operation of the device? A. Yes. He says he prefers to include it, but it is not necessary.

Q. Now, take Hewitt Patent No. 1,393,369, were the use of resistances and inductances common in mercury devices for the purposes of stabilization? A. Yes.

Q. And the resistances 19 and 20, in Fig. 2 would have the same purpose, would they not? A. I do not believe that he has disclosed that this Fig. 2 is a mercury device.

Q. Don't you understand it to be such from its appearance? A. No, I don't.

Q. What kind of device do you think it is? A. It appears to me to be an electronic device.

Q. You don't know? A. I don't know.

Q. When the specification states, page 2, lines 19 to 25, that the filament acts as a negative to receive positive current, the patentee is referring, is he not, to the operation of the tube in the

940 *Raymond T. Cloud—For Defendant—Cross.*

ionized or gas conduction state? A. Not necessarily.

Q. You don't so understand him? Is that the reason the inductance 19 and the resistance 20 are both necessary to maintain the stability of the current? A. It may have been.

941 Q. Tell me why the grid 16 is enclosed in glass? Doesn't this show that the tube operates by gaseous ionization? A. He states, starting with line 7, "The perforate terminal wire forming the grid might be covered with a coating of glass, preferably thin or other suitable insulating material."

Q. You need the insulation, do you? A. Not necessarily. In other words you could create an electric field with the grid covered with glass in a pure electron device.

Q. You have done that, have you? A. I have done essentially the same thing.

Q. Have you done that? A. I have had the grid outside the tube.

942 Q. That isn't what you said. A. No.

Q. Now, take up Patent 1,403,475, the Arnold patent for the resistance capacity coupling and select the best reference against that. A. Fig. 6 of Patent No. 1,129,942.

Q. That is the same Arnold patent you referred to before? A. Yes.

The Court: That is tab 10?

The Witness: Yes.

Q. Now, in defendant's circuit, it is desirable, is not, to have as little distortion as possible in the circuit from the photo-electric cell to the input of the first tube? A. Yes.

Raymond T. Cloud—For Defendant—Cross.

Q. You refer to which inductance in Fig. 6 of this Patent No. 1,129,942? A. That is the coupling between the first and second stage or the second and third inductance 17, condenser 18 and resistance 14.

Q. Now, will you take up the Arnold Patent 1,448,550 and state the best reference in regard to it? A. I believe Van Der Bijl No. 1,350,752, tab No. 23.

Mr. Ashton: I call your Honor's attention to the fact that the application date of this Van Der Bijl patent as well as the other ones relied upon by the defendant are all later than the effective which we have proved for this patent in suit.

Mr. Darby: You mean what you seek to prove. I do not want to accept that statement.

The Court: Which he asserts he has proved.

Q. Now, patent in suit 1,465,332, select the best reference to it, this being the Common Plate Supply Patent. A. That is Patent No. 1,129,942, which is tab No. 10 again in this case.

Q. Now, as a practical man in this radio and amplifier art, it is important, is it not, Mr. Cloud to keep the AC in the second tube from getting back into the input of that tube through the battery? A. Yes, it is important in any case to keep the AC current out of the DC.

Q. Now, we refer to the Campbell Patent 1,227,113 which you referred to as to the Common Plate Supply Patent; can you state the filter theory of this patent, or is it a big job?

946 *Raymond T. Cloud—For Defendant—Cross.*

A. Well, I believe I can perhaps, by referring to some notes.

The Court: Is that the one Mr. Darby wanted me to read at my convenience?

Mr. Ashton: Yes, your Honor. This is known as the Campbell filter, isn't it?

The Witness: Yes.

Q. That is used so widely? A. Yes. There are four types of Campbell filter: Low pass, 947 where it passes all the frequencies below a certain frequency; high pass, where it holds back all the frequencies below a certain frequency and passes all above that frequency; the band pass, whereby it passes frequencies between given low frequency and a given high frequency; and band elimination filter where the filter rejects certain frequencies and allows all other frequencies to pass below and above that frequency. In this particular case involved in this suit, there is what is called a low pass filter. Then again we can sub-divide each one of these filters to ladder or bridge types.

948 Q. Have you been looking this up during the week-end, Mr. Cloud? A. Oh, I have worked on filters for years.

Q. I was just wondering whether you were preparing a lecture on it or whether you wanted to go through this from the point of view of your side of the case.

Mr. Darby: This is cross examination, Mr. Ashton, and he was answering your question.

Mr. Ashton: If you wish him to continue—

Mr. Darby: I don't.

The Witness: I was prepared the other day, but I did not want to go into it in detail, because we were rushing through the case.

Q. I refer you to the Alexanderson Patent No. 1,340,101; are not the tubes shown in this patent four-element tubes? A. Yes.

Q. Are they not variable impedance tubes? A. There is nothing to indicate that they are variable impedance tubes by the drawing. 950

Q. Do you know whether they are or not as disclosed in the patent? A. No, I do not.

Q. I believe you testified the other day that the plate supply is from the generator 1. A. Yes.

Q. You meant from the battery 16, did you not? A. Yes, I should have said battery 16. Generator 1 also super-imposes on that supply for transmitting—no, I am wrong about that. It is from the battery 16. ♦

Q. Now, Patent No. 1,520,994, the Gain Control Patent; which is the best reference as to that? 951

The Court: I guess we can agree that lines 19 and 18 the word there should be "amplifier" not "implifier"; I am not sure that the word "implifier" isn't the more appropriate.

Mr. Ashton: I will concede that, your Honor. I had not noticed that.

The Witness: We can use Van Der Bijl 1,350,752, tab No. 23.

Q. Is that the same one that you selected for the other patent? A. Yes, for the resistances.

952 *Raymond T. Cloud—For Defendant—Cross.*

Mr. Ashton: I also call your Honor's attention to the fact that it is the plaintiffs' position that the date of this patent goes back to 1914 at least.

Q. As a practical man in this art, Mr. Cloud, it is very useful in installing talking motion picture systems, is it not, to be able to make an adjustment by means of the gain control such as the gain control of the Arnold patent? A. Yes.

953 Q. And you can adjust it for particular devices, can you, as to the amount of gain which you may need? A. Yes, that is the manner in which it is used.

Q. Do you recall Mr. Kendall's testimony with regard to trying to accomplish an improved result prior to March, 1914, by adjusting the B supply? A. Yes.

Q. Would you prefer the gain control to that method? A. Yes, I would.

(Discussion off the record.)

954 Mr. Darby: You don't want the Court to be under the impression that the B supply affects the filament, do you?

Mr. Ashton: You may deal with it as you please.

The Court: Is there a distinction between the B supply and B battery? I thought your opening statement was that the B battery supplied the filament, however, I may be misquoting you in that.

Mr. Ashton: No, it is the A battery that heats the filament; it is the B battery that furnishes the plate current and the C battery put the potential on the grid.

Mr. Darby: I did not think you wanted the Court to be under a misapprehension.

Mr. Ashton: No.

Q. Now, refer if you will, Mr. Cloud, to this Arnold Patent No. 1,448,550 in suit, which you have cited against the Patent 1,520,994; it seemed to me that you had some difficulty in recalling when you were first familiar with potentiometers this morning, and I don't think you stated when you first knew of the use of the potentiometer in connection with the three-element vacuum tube of the audion type. A. Well, I will say it was around 1915 or 1916.

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Mr. Ashton: I call your Honor's attention again that the date of this patent in suit is much earlier than that.

Q. You did not mean to suggest that the resistance in the Johnson Patent 1,432,865 which you referred to was a gain control potentiometer such as shown in the Arnold patent, did you? A. No, I did not mean to suggest that that was the gain control.

957

Re-direct Examination by Mr. Darby:

Q. Mr. Cloud, in discussing the Straight Line Characteristic Patent in cross examination you made the statement that the load resistance in the output circuit had no effect, or no appreciable effect, on the characteristic curve of the high frequency currents. Is that correct? A. That is correct.

Q. Did it have effect on the characteristic

958 *Raymond T. Cloud—For Defendant—Re-direct.*

curve of the low frequency currents? A. It did.

Q. And what effect did it have? A. It would result in a mismatch if too low, and would distort the low frequency characteristics.

Q. In other words, when the output circuit has both high frequency currents and low frequency currents, is it just as essential to keep the low frequency currents undistorted as it is where the output circuit has just low frequency currents? A. It is just as essential.

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Mr. Ashton: With reference to what prior patent was that, Mr. Darby, may I ask?

Mr. Darby: I do not recall which one it was, but it is a fundamental proposition.

The Witness: With reference to the modulation.

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Q. Likewise in discussing the Kendall patent 1,330,471 you referred to the vacuum tube circuit in the middle of the arrangement in the centre of the page, as being a detector. What other function does the vacuum tube in that circuit serve? A. Detection is accompanied with amplification in the usual arrangement of detectors, using the vacuum tube for detection.

Q. Do I understand that it is both the detector and amplifier? A. It is.

Q. You also testified on cross examination that inductance and capacity are used whenever alternating current and direct currents are employed, and it is desirable to keep the effects thereof separate. How long have inductances

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bridged by condensers or their capacities been used for that purpose to your knowledge? A. Since 1905.

Q. Is that arrangement something that is commonly employed in telephone service? A. Yes, it is commonly employed in common battery exchanges to keep the voice currents out of the common battery supply that supplies all of the telephone instruments. The particular application I have in mind is in the operators' sets on a common battery exchange, where they employ a choke and condenser for that purpose.

Q. And how long in the commercial field have you been familiar with the employment of that arrangement for that purpose? A. Since 1905.

Q. In your cross examination you stated that certain equipment—and I do not recall what equipment it was at this moment—was not used for talking motion pictures but only in connection with incidental music. Will you please briefly explain what you mean by that statement? A. The equipment that I manufactured and was engaged in manufacturing at that time used phonograph records which were amplified and reproduced in loud speakers for incidental music in motion picture theatres.

Q. What I am concerned with is what is the technical meaning of incidental music in the talking motion picture field? A. Well in the old day they used a pipe organ which arranged special music to accompany the picture, without the talking, and this arrangement was arranged to play the proper musical accompaniment to a picture, using phonograph records for that purpose.

Q. So instead of having the spoken action they

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964 *Raymond T. Cloud—For Defendant—Re-cross.*

merely had music to accompany the visual exhibition; is that right? A. Yes.

Q. I believe you likewise stated that your office is next door to the office of General Talking Pictures. Do you mean you are in the same building? A. No, we are in adjoining buildings. They are at 217, I believe, and we are at 220.

Re-cross Examination by Mr. Ashton:

965 Q. In your patent 1,907,741 that you referred to this morning, you were relying in 1930 upon the special construction of a transformer, were you not? A. That was a portion of the patent.

The Court: Is this re-cross?

Mr. Ashton: Yes.

The Court: Has this to do with matters brought out on the re-direct?

Mr. Ashton: Yes, it has specifically to do with that.

966 Q. And you were also relying upon the resistance 9 in the input circuit of Fig. 1?

Mr. Darby: Which patent are you referring to?

Mr. Ashton: This patent 1,907,741.

Mr. Darby: Will you be more definite in your question? What do you mean by "relying"?

Mr. Ashton: I mean that that is part of the disclosure—the arrangement of that resistance.

A. That was not part of the patent.

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Q. It was not any part of it? A. It was not claimed as part of the patent. We disclaimed the use of the resistance shunted—

Q. Wasn't it claimed in combination with the condenser C, as shunting the condenser C? A. We disclaimed that particular arrangement of condenser shunted with a resistance. It may be a part in combination with other things.

Q. What is meant in Claim 15 when it says, "said means comprising a capacity device in said circuit"?

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Mr. Darby: I object, if your Honor please.

Mr. Ashton: Mr. Darby brought out in his cross examination, your Honor, that impedances and condensers and things of that sort were used a long time ago. This witness is actually claiming in 1930 arrangements of those things, and that is the reason for my examination.

The Court: Are those two statements inconsistent?

Mr. Ashton: Mr. Darby's re-direct examination was to give your Honor the implication that these elements that we have been talking about here—

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The Court: Inductance and capacity.

Mr. Ashton: Yes—were very old things. The witness himself is claiming them as elements in this patent which he applied for in 1930.

Mr. Darby: Even so, I do not see that.

The Court: Let us have the evidence.

Q. What were you referring to in that Claim 15, by "said means comprising a capacity de-

970 *Raymond T. Cloud—For Defendant—Re-cross.*

vice in said circuit"? A. We are not claiming the capacity enters into the thing. Capacity and inductance and resistance are primeval or primary elements, and they may be recombined in many ways to form patents.

Q. Even in 1930? A. Even in 1940.

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Mr. Darby: If the Court please, that concludes the patent side of this case, and from now on we will confine ourselves expressly to the law side.

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On the law side, if I may take a moment to crystallize what the evidence thus far has established, by stipulation or undisputed evidence thus far the facts are that the defendant's apparatus before the Court under charge of infringement was manufactured by The American Transformer Company and sold to the defendant. The American Transformer Company was licensed under each of the patents in suit, by virtue of a license set up that started with cross-license arrangements between the General Electric Company and the Radio Corporation of America and the American Telephone and Telegraph Company, by a document which granted a license to The American Transformer Company, which license was joined in by the American Telephone and Telegraph Company, and that the apparatus before the Court under charge of infringement was manufactured by the American Transformer Company under that license.

That license was limited by express language in the license agreement to a certain use. The apparatus was sold to us with that limited license of use, in accordance with the express terms of the American Transformer license, noticed right on the instrument itself.

That takes care of the apparatus itself, so that it raises a square issue here, about which there is no contention as I understand it, that if the American Transformer Company had sold this apparatus to somebody, to us for example, and we had used it in connection with radio receiving sets for receiving broadcast news and music, there would be no question but that was perfectly legal and within the license. And there is likewise no question that that same apparatus could be used and in fact was so used for that purpose—that is, apparatus similar to it in every respect. That takes care of the circuit apparatus, the chassis or whatever you want to call it. The apparatus is absolutely of no utility as sold without tubes.

This original set-up between the General Electric Company, American Telephone and Telegraph Company, Radio Corporation of America and the remainder of the parties entering into that patent pool also included the patents for tubes, and under that set-up until about 1929, the late Fall of 1929, the only licensed manufacturer of radio tubes under this group of patents at least, was the Radio Corporation of America. The Radio Corporation of America

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was not a licensed manufacturer. Let me correct that. The arrangement was that the Radio Corporation of America was the sole selling agent of the Westinghouse Company and the General Electric Company—the Westinghouse Company manufacturing 40 per cent. of the requirements of the Radio Corporation and the General Electric Company manufacturing 60 per cent. of its requirements.

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At that time, prior to the Fall of 1929, there was another source of supply of vacuum tubes, known as the Cunningham tube. The Cunningham tube was manufactured by either the Westinghouse Company or the General Electric Company and allowed to be sold by the Cunningham Company under the name "Cunningham," although they were really a Radio Corporation or Westinghouse Electric tube. They were sold in competition with the ordinary Radio Corporation tube, although they were virtually the same.

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In the Fall of 1929, the Radio Corporation started to grant licenses under the vacuum tube patents. That was after the anti-trust suit in Delaware. Their first licensee was the Raytheon Company, a company located right outside of Boston. The second licensee likewise about ten days or two weeks after granting the Raytheon license was known as the National Union Radio Company, which was a corporation composed of three or four of the plaintiffs in the Delaware anti-trust litigation. From that time on, the Radio

Corporation have granted licenses to a number of tube manufacturers.

The licenses granted to the tube manufacturers likewise were restricted as to use, and the license contracts likewise provided that the tubes should be marked, or the cartons containing the tubes should be marked with approved language carrying with them as they were sold, this restriction notice.

It is agreed between us that the various notices which were incorporated with respect to tubes either on the carton or in literature enclosed in the carton with the tube, were of the following form. With respect to the RCA:

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"LICENSE NOTICE.

"In connection with devices it sells, Radio Corporation of America has rights under patents having claims (a) on the devices themselves and (b) on combination of the devices with other devices or elements, as for example in various circuits and hook-ups.

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"The sale of this device carries a license under the patent claims of (a), but only for (1) talking machine uses, (2) radio amateur uses, (3) radio experimental uses and (4) radio broadcast reception; and only where no business features are involved.

"The sale does not carry a license under patent claims of (b), except only (1) for legitimate renewals and repairs in appa-

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ratus and systems already licensed for use under such patent claims on combinations, (2) for assembling by amateurs and experimenters, ~~and not by others~~, with other licensed parts or devices, or with parts or devices made by themselves, but only for their own amateur and experimental radio uses where no business features are involved, and not for sale to or for use by others, and (3) for use with licensed talking machines and licensed radio broadcast receiving devices; and only where no business features are involved.

"This device is licensed for no other use unless, by special written contract of sale with Radio Corporation of America, the purchaser has agreed to use it in some other special manner only, as set forth in the contract of sale. The right to employ the device in such special manner is non-transferable except by special agreement with Radio Corporation of America."

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The license notice with the Cunningham tubes—

Mr. Ashton: I wish to say, Mr. Darby, as to your reference to these other notices, the Cunningham, I believe you have in mind, and referring to the Raytheon notice, I have no objection to agreeing that these notices have been used, but I would like you to prove that you have purchased tubes from these concerns.

Mr. Darby: We will.

Mr. Ashton: Before the filing of the bill of complaint.

Mr. Darby: So far as the Raytheon is concerned, we did not purchase those tubes before the filing of the bill of complaint, because the Raytheon Company was not in business before the filing of the bill of complaint.

Mr. Ashton: The license was dated March 19, 1929, and the bill was filed in September of the same year.

Mr. Darby: All right. As to the Cunningham license, I shall not take the time to read it, but will ask the stenographer to spread it on the minutes. It is substantially that of the Radio Corporation of America, except that it does not contain the last two sentences, but substitutes therefor this statement:

"Manufactured and sold under rights, patents, and inventions owned and/or controlled by Radio Corporation of America."

The Court: Does that mean that the entire last paragraph of the license notice which you have already read, does not appear in the Cunningham license?

Mr. Darby: That is correct, your Honor.

The Court: That last paragraph consists of two sentences.

Mr. Darby: That is right, your Honor, and substituted for that last paragraph was the statement that I have just read.

(The Cunningham license is as follows):

"LICENSE NOTICE.

"The sale of this device carries a license under patent claims on the device

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itself but only for (1) talking machine uses, (2) radio amateur uses, (3) radio experimental uses and (4) radio broadcast reception; and only where no business features are involved.

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"The sale does not carry a license under patent claims on combinations of the device with other devices or elements, as for example in various circuits and hook-ups, except only (1) for legitimate renewals and repairs in apparatus and systems already licensed for use under such patent claims on combinations, (2) for assembling by amateurs and experimenters, and not by others, with other licensed parts or devices, or with parts or devices made by themselves, but only for their own amateur and experimental radio uses where no business features are involved, and not for sale to or for use by others, and (3) for use with licensed talking machines and licensed radio broadcast receiving devices; and only where no business features are involved.

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"Manufactured and sold under rights, patents and inventions owned and/or controlled by Radio Corporation of America."

Mr. Darby: The license notice on the Raytheon tubes, and this is comparatively a recent tube, and I have no doubt in the world but what this particular license notice was subsequent to the license to the Raytheon Company.

Mr. Ashton: It is in the agreement itself.

Mr. Darby: It is? Where is it?

Mr. Ashton: Right here (indicating).

Will you read it from the agreement, Mr. Darby?

Mr. Darby: Yes, I will. The license attached to the Raytheon tubes, in any of the manners I have already indicated, provided that the license which is dated March 19, 1929,—it is earlier than I thought it was, it is as follows:

“LICENCE NOTICE.

“This device is licensed under patent 992 claims of Radio Corporation of America on the device itself but only for use in radio broadcast reception and reproduction of sound and pictures from records, to be heard or seen in the immediate vicinity of the apparatus used in such reproduction (not including transmission to, or reception at, other points of such sound and pictures), and in each case only for private use in homes for educational and entertainment purposes. It is not licensed under patent claims on combinations of 993 the device with other devices or elements, as for example in various circuits and hook-ups, except only for use in apparatus and systems already licensed for use under such patent claims on combinations.”

And in connection with the Raytheon Company, it is customary to print that license notice on the tab of the carton on which the vacuum tube is sold.

The Court: Is there any question that the form of notice as printed on the carton is the same as that right in the agreement.

Mr. Aston: No, there is not, your Honor.

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Mr. Darby: I might state my point in putting in the Raytheon notice is to show, in connection with the Raytheon, beginning at that time, they began to expand the license use to which the tube might be put, and I am going to argue rather strenuously, if the plaintiffs' theory is sound, they could carry that to a point where it would demonstrate far more effectively perhaps than I can, the unsoundness of it.

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It is likewise stipulated that the following is a complete list of the licensees under the patents in suit as well as the date of the licenses granted and the date of expiration thereof, which licenses were the same in so far as this case is concerned with the license that was granted to the American Transformer Company. Is that correctly stated?

Mr. Ashton: I think so, subject to check. No doubt it is so.

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Mr. Darby: I am accepting your statement that it is correct and I might note, if your Honor please, that there are 51 licensees in all and the licenses begin as early as—

Mr. Ashton: All about the same date.

Mr. Darby: Here is one that is dated February 1, 1927.

Mr. Ashton: Which is the date of the American Transformer license.

Mr. Darby: It is, yes. That was the General Radio Company, though.

May this be copied into the record?

The Court: Yes, copy that in the record in full.

POWER SUPPLY LICENSES EVER ISSUED

Name of Company	Date of Licenses	Date of Expiration	Assignment	
Air-Chrome Studios, Inc	7/1/29	8/1/31		
Air American Mohawk Corp.		8/1/31	Assigned from Mohawk Corp. of Illinois 6/4/28	
American Transformer Co.	2/1/27	8/1/31		
Autorad Electric Corp.	5/31/28	8/1/31		
Bremer Tally Mfg. Co.	7/19/27	8/1/31		998
Buckingham Radio Corp. (Ill. Corp.)	1/1/29		Assigned to Buckingham Radio Corp. (Del. Corp.) 5/31/29	
Buckingham Radio Corp. (Del. Corp.)		10/7/29	Assigned from Buckingham Radio Corp. (Ill. Corp.) 5/31/29	
Consolidated Radio Corp.	8/21/27		Assigned to United Reproducers Corp. 4/17/29	
Crosley Radio Corp.	7/15/27	8/1/31		
H. H. Eby Mfg. Co.	5/2/28	8/1/31		
Electrad, Inc.	4/12/29	8/1/31		
Electrical Research Lab. Inc.	7/1/28	2/27/31		999
Enterprise Mfg. Co. of Pa.	11/17/27	8/1/31		
Farrand Mfg. Co., Inc.	2/1/27	8/1/31		
Ferranti, Inc.	11/1/28	8/1/31		
Federal Tel. Mfg. Co.	6/10/27		Assigned to Acoustic Products Co. (later called Sonora Products Corp. of America) 6/29/29	
General Amplifier Co.		8/1/31	Assigned from Martin Copeland Co. 5/15/29	
General Household Utilities Co. formerly U. S. Radio & Television		8/1/31	Assigned from U. S. Electric Corporation 1/1/29	
General Industries Co.	8/19/29	8/1/31		

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<i>Name of Company</i>	<i>Date of Licenses</i>	<i>Date of Expiration</i>	<i>Assignment</i>
General Radio Co.	2/1/27	8/1/31	
Gilfillan Bros., Inc.	7/1/27	8/1/31	
A. R. Goodwin (doing business under Chelsea Radio Co.)	9/21/27	7/1/28	
Gray Products, Inc.	3/22/29	8/1/31	
A. H. Grebe & Co., Inc.	8/1/27	8/1/31	
Grigsby-Grunow Co.		8/1/31	Assigned from Pfanstiehl Radio Co. 4/15/28
1001			
Howard Radio Company	6/10/27	8/1/31	
King Manufacturing Corp.	6/1/27	1/1/31	
Kingston Products Corp.	5/2/28	8/1/31	
Kolster Radio Corp. (formerly Federal Brandes)	8/1/27	2/6/30	
Martin Copeland Company	2/1/27		Assigned to General Amplifier Co. 5/15/29
Mowhawk Corp. of Illinois	6/14/27		Assigned to All American Mohawk Corp. 6/4/28
Wm. J. Murdock Co.	6/28/27		Assigned to Philadelphia Storage Battery Co. 2/10/28
1002			
National Co., Inc.	2/1/27	8/1/33	
Pfanstiehl Radio Co.	8/1/27		Assigned to Grigsby-Grunow Co. 4/15/28
Philadelphia Storage Battery Co.		8/1/31	Assigned from Wm. J. Murdock Co. 2/10/28
Harold J. Power, Inc.	6/27/27	12/1/28	
Radiart Lab., Inc.	5/3/29	8/1/31	
Radio Receptor Co., Inc.	2/1/27	8/1/31	
Sonora Products Corp. of Am. (formerly Acoustic Pro. Co.)		10/3/30	Assigned from Federal Tel. Mfg. Co. 9/29/29 to Acoustic Products Co.
Splitdorf Radio Corp.	4/25/28	8/1/31	

Name of Company	Date of Licenses	Date of Expiration	Assignment	
Steinite Radio Co. (Kansas Corp.)	2/1/27		Assigned to Steinite Co. (Delaware Corp.) 3/6/28	
Steinite Mfg. Co. (formerly The Steinite Co.)		8/1/31	Assigned from Steinite Radio Company 3/6/28	
Sterling Mfg. Company	2/1/27	8/1/31		
Stewart-Warner Corp. (formerly Stewart-Warner Speedometer Corporation)	8/1/27	8/1/31		
Stromberg-Carlson Tel. Mfg. Co.	5/1/27	8/1/31		1004
Temple Corporation	12/1/28	2/6/30		
Thordarson Electric Mfg. Co.	1/1/29	8/1/31		
U. S. Timmons, Inc.	2/1/27	8/1/31		
United Reproducers Corp.		10/3/30	Assigned from Consolidated Radio Corp. 4/17/29	
United States Electric Corp.	8/1/27		Assigned to U. S. Radio & Television Corp. (now General Household Utilities Co.) 1/1/29	
Zenith Radio Corporation	2/1/27	8/1/31		1005

Mr. Darby: Now, with the Court's permission I will turn over this phase of the case to my associate.

Mr. Berliner: May it please the Court, before I proceed with the witnesses, at the opening of the defense, there were certain documents marked A, B, C and D.

Mr. Ashton: The first agreement that you offered was A. We have no loose copy of it, and a copy will have to be prepared. However, it is in the Independent record which we will have identified similarly to

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the way the Lowenstein record was identified.

Mr. Darby: I will assume the burden of making copies of what you have not spare copies of.

Mr. Ashton: We have the other agreements.

Mr. Darby: The 1926 agreement?

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Mr. Ashton: Yes; also agreement B between General Electric and American Telephone and Telegraph; the next is General Electric and American Telephone and Telegraph Company and Radio Corporation of American and Western Electric Company and also the 1926 agreement.

The Court: For the purpose of clarity, can we refer to them by their exhibit letters?

Mr. Ashton: I think so.

The Court: Suppose you call the missing one A; is that the first in point of time?

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Mr. Darby: Yes, your Honor. That is the one I will make a copy of. The date of that is November 20, 1919.

The Court: And the parties?

Mr. Darby: General Electric Company and Radio Corporation of America.

Mr. Ashton: The parties are the Marconi Company.

Mr. Darby: No, it is General Electric Company and Radio Corporation of America.

The Court: That is Defendant's Exhibit A. Now, Exhibit B is what?

Mr. Darby: Exhibit B is the General

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Electric Company and American Telephone and Telegraph Company agreement that is dated July 1, 1920.

The Court: You have a copy of that, have you?

Mr. Ashton: Yes. I was misinformed, when these copies were handed me. This 1919 agreement is in these extra binders we have, so it can be marked right now.

(Marked Defendant's Exhibits A and B respectively.)

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Mr. Darby: Exhibit C is the General Electric-American Telephone and Telegraph and Radio Corporation of America and Western Electric Company contract dated July 1, 1920.

(Marked Defendant's Exhibit C.)

Mr. Darby: We have the 1926 agreement.

The Court: What is the exact date?

Mr. Ashton: July 1, 1926.

The Court: What parties?

Mr. Darby: General Electric Company and American Telephone and Telegraph Company.

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CHARLES L. LOUGHEAD, called as a witness on behalf of the defendant, having been duly sworn, testified as follows:

Direct Examination by Mr. Berliner:

At the present time, I have no occupation. My residence is East Orange. I know the Amer-

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ican Transformer Company of Newark, New Jersey. I was president from about the middle of June, 1929, to about the 1st of March last year and was in active charge of its operations. It is the company mentioned in the testimony here and was engaged while I was with it in the manufacture of transformers, amplifiers, and sound equipment of various kinds and things allied with the transformer business. It was under the RCA license which has been marked

1013 Defendant's Exhibit E.

Mr. Schermerhorn of the American Transformer is vice-president in charge of manufacturing and engineering. Mr. Zeloney has been a manufacturer's agent representing them in the sale and disposition of amplifiers.

I know General Talking Pictures Corporation, the defendant in this suit and also know Mr. Schlesinger of that company. I first met him about the 1st of July, 1929,—I don't know whether that is the exact time or whether it was before that. I may have seen him more than once just before that time, I am not certain. I was asked to go over to meet his brother who was here from South Africa, and Mr. Schlesinger and his brother wanted to discuss the purchase from us of quite a number of amplifiers, I presume for talking pictures, although I don't remember when it was.

The Court: If you don't remember, just tell us; don't tell us what you presume.

I think that was my first discussion; I am not sure that there were two. Mr. Schlesinger wanted to know, if I remember, our facilities



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for manufacturing and our ability to supply a considerable quantity of amplifiers and as to our license, and the terms under which we could sell them. I don't remember whether the question was asked or not whether we were paying royalties. I met him at the office of the General Talking Pictures Corporation at Times Square. As a result of that conversation with him, this letter was prepared, and mailed or delivered to General Talking Pictures Corporation.

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Mr. Berliner: I offer that letter in evidence.

(Marked Defendant's Exhibit J.)

The Court: Let me look at it a minute.
(Document handed to the Court.)

After this letter which is dated July 16, 1929, I or my company had occasion to write a second letter to General Talking Pictures Corporation. I think they asked for some change in the original letter,—I don't think the change was with respect to any option. The second, which you hand me, is a letter from American Transformer Company to General Talking Pictures Corporation, dated July 24, 1929. I signed both letters.

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Mr. Berliner: I offer that letter in evidence.

(Marked Defendant's Exhibit K.)

The representative of Western Electric mentioned in the letter of July 16 is Mr. H. E. Young. He is here in court. I think his title was general commercial engineer with the Western Electric; but I am not sure. I could not be

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at all definite as to how long before the writing of this letter of July 16, Exhibit J, I had conversations with Mr. Young. It was later than the 15th of June. I cannot give a definite conversation, but can give the substance of one conversation, which I cannot be certain is the one referred to here. We were not talking about this matter at all, but in the course of the conversation the matter or subject matter of General Talking Pictures with Mr. Schlesinger came up in some way. I cannot remember which way the conversation came up, but at any rate one of us said, "Well, at any rate do you think the General Talking Pictures would go out of business if we did not sell them amplifiers?" And we both agreed they would not. He raised no objection to our proposed selling of amplifiers to General Talking Pictures Corporation. We had been selling them to General Talking Pictures Corporation before July, 1929, and since February, 1929, approximately—I do not know the original date. But no objection was raised by him.

At that time, prior to the writing of the July 16th letter, I may have received report from Mr. Zelony, the manufacturer's agent, whom I mentioned before with respect to General Talking Pictures Corporation, but I don't know. He was there frequently and we talked. I cannot say as to that. I don't remember that he had spoken to me that he had had talks with the Western Electric representatives.

The fifth paragraph of the letter of July 16th states that I was informed that a representative of the Western Electric examined one of these amplifiers which we had installed in a theatre

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and as to that particular amplifier he stated that it appeared to be very high grade product. I do not at this moment recollect who that representative was. It was to someone in our organization.

Before writing these two letters and sending them to General Talking Pictures Corporation I took them up, or the subject matter of them with the board of directors of my company. I think both letters. They approved the sending of those letters. I also consulted with our counsel Mr. Charles Lum of Newark, of Lum, Tamblyn & Colyer and submitted to him the subject matter of these letters before they were sent. He approved sending them.

Q. You knew, did you not, from the dates of those letters down to the time you finished your work with the company that General Talking Pictures Corporation was engaged in supplying talking motion picture equipment to theatres.
A. Well, I cannot say that I knew it from having seen them; but I had no doubt.

Q. You mean you had not seen them in theatres?
A. Never saw them in theatres. I cannot tell you how I knew it; but I knew they were.

My company sent reports regularly to the Radio Corporation of America, under our license. With respect to the amplifiers sold I think they were quarterly reports and were required to be sent under the license agreement with a royalty statement and check attached for seven and a half per cent. per equipment. My company first began to include in these royalty statements the name General Talking Pictures Corporation as a purchaser of these amplifiers about the 1st of December, 1929. I was not

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there at the time. I was sick. I was away for three months—four months—five months. Before that no names had been furnished. The license did not require it.

Q. It is a fact, then, that the names began to be furnished from December, 1929, on, at the request of the Radio Corporation of America?
A. I don't know. They requested, that is all I know.

1025 From December, 1929, to the expiration of our license, I believe in August, 1931, these quarterly statements with the name General Talking Pictures Corporation mentioned thereon, were regularly sent to the R. C. A. whenever we sold them any.

Our largest customer for amplifiers during the period 1929, to August, 1931, was General Talking Pictures.

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Mr. Berliner: I offer in evidence a complete list of the statements—they have been stipulated—commencing with the one forwarded July, 1929, the first covering the quarter commencing April, 1929. The period covered is April, 1929, though the report was forwarded in July.

Mr. Ashton: Although we have no specific objection to the reports, your Honor, as to their proof and so on, I wish to note on the record that the suit was actually brought on September 6, 1929. The first report giving the names of customers was on December 7, 1929.

Mr. Berliner: It covers the period to July, 31, 1931.

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The Court: You say the suit was brought in September, 1929?

Mr. Berliner: 1929. From that list furnished by Mr. Ashton I have excluded one letter which refers to checks I have no knowledge of. I do not think he cares about it. It is dated October 28th.

(List marked Defendant's Exhibit L.)

I think we sold our amplifiers to others for use in talking picture reproduction, outside of General Talking Pictures Corporation, but I don't know. We had occasional customers. I don't know that they were used for that, though we offered them for sale for that purpose.

I think that with each royalty statement, or approximately the time the royalty statement was sent, a check for royalties was forwarded by our company to the Radio Corporation of America.

From the time that the company commenced giving the names of General Talking Pictures Corporation and other users of amplifiers for talking pictures, in December, 1929, for a period of approximately one year thereafter, that is until December, 1930, those royalty checks were sent to and accepted by the Radio Corporation of America, as far as I know. No protest was made on their part until that period.

No notice was ever sent to us objecting to such procedure or business on our part. I had occasion during that period to confer at times with representatives of the Radio Corporation of America from December, 1929 to December, 1930—one year;—well, about that period, from the date of the first royalty statement on which

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1030 *Charles L. Loughead—For Defendant—Direct.*

the names appeared. Not to my recollection, at any of those conferences, did they in any wise object to our sale of these amplifiers to General Talking Pictures Corporation. The first protest that we received was in December, 1930. Thereafter, we continued to send them royalty statements, I think, mentioning General Talking Pictures Corporation. I have not seen them. They are on that list. And accompanying those statements were checks of the company, for the royalties.

1031

The license to the American Transformer Company which is here in evidence was never cancelled. It expired by its own limitation. As a matter of fact I had discussions with the Radio Corporation representatives and Western-Electric representatives with a view to extending the license. Such a license was in course of preparation with Electrical Research Products, but not with the Radio Corporation.

1032

This paper which you show me was printed, before I was with the company, but I recognize it as something that the American Transformer Company had issued. I think I have seen it.

Mr. Berliner: Showing that he offered these transformers for sale for theatre purposes.

Mr. Ashton: What is the date on it?

Mr. Berliner: 1928.

Mr. Ashton: I do not see that it has any bearing, your Honor.

Mr. Berliner: I offer it not by way of constituting an admission against the plaintiffs, but by way of acquiescence, that is all.

The Court: A man cannot acquiesce in anything that he does not know about.

Mr. Berliner: The witness will testify they were circularized, all over.

The Court: They might have been circularized and the plaintiffs not know about it.

Mr. Berliner: That is so, but may I ask some preliminary questions about it?

The Court: Maybe Mr. Ashton will admit it.

Mr. Ashton: I object to it, your Honor. In the first place, Mr. Loughead said he was not there when this circular was put out, and I do not see how he can testify to it.

Mr. Berliner: I have a man here to testify to it, but it is simply a question of saving time. If that is your only objection I will put a man on to testify to it.

The Court: Then, the offer is withdrawn at this time.

The Witness: To my knowledge American Transformer Company issued catalogues and circulars advertising amplifiers.

Mr. Ashton: I object to this line of examination, your Honor, on the ground that the suit was brought before these things had taken place, and it does not seem to me that they can have any possible bearing as an estoppel or anything else.

The Court: I would not be disposed to argue that with you, but the testimony thus far, if I understand it, is that during the year 1930, which would be the year following the suit, this American Trans-

1036

Case.

former Company sold its device to this defendant, reported that fact to the plaintiff and paid the plaintiff a royalty based upon such sales.

Mr. Ashton: It will appear that all those royalties were refunded as soon as practicable after they were discovered.

The Court: I am merely speaking of the evidence to date.

1037

Mr. Ashton: You see with that additional fact it will appear that they really have no bearing at all.

The Court: These circulars, you mean?

Mr. Berliner: Whether they were refunded or not is immaterial as a question of law.

Mr. Ashton: Perhaps more important, your Honor, is also the fact that any royalties were not paid to the plaintiff anyway.

Mr. Berliner: They were paid under the license agreement to the R. C. A.

1038

The Court: Under the guise of discussing catalogues and such things don't let us get into anything else. I simply say that is the state of the record at this time.

Mr. Ashton: I object to the line of examination, including that to which the last question was directed, upon the ground that it cannot have any bearing on the question of estoppel or license after the suit has been pending for some time.

The Court: I suppose his idea is that it may go to the plaintiffs' knowledge of the nature of the business of the licensee.

Mr. Berliner: Right.

The Court: I suppose that is the purpose of it.

Mr. Ashton: But you see the suit had already been brought long before this took place.

The Court: The suit was brought in September, 1929, which was the ninth month of the year. I will let him show what the company did, with the hope that he will connect it, and if he cannot I will entertain a motion to strike out.

1040

The Witness: The company issued circulars and catalogues regularly as part of its business advertising amplifiers. Well, I cannot testify from personal knowledge. I did not send out any, as far as I know, but I do know that they were sent out.

Q. Do you know to whom they were sent out, generally?

Mr. Ashton: That is pretty remote, your Honor, now. If he knows that they were sent out?

1041

Mr. Berliner: I will connect it in a moment.

Mr. Ashton: I think he is going very far afield, if we get into these details.

The Court: I realize that possibility, but as a practical matter a president of a company might know, and he might, for instance, buy lists of customers. We know such things are done. He may be leading to that; I do not know.

Mr. Ashton: I would like to know what the point is.

1042 Charles L. Loughead—For Defendant & Direct.

Mr. Berliner: Knowledge on the part of the plaintiffs.

Mr. Ashton: Are you suggesting that we received them; is that the point?

Mr. Berliner: Yes, that you had knowledge of them. That you received them.

Mr. Ashton: You might ask the witness that.

Mr. Berliner: I would if you had not objected.

1043 The Witness: I don't know whether we had the electrical companies on our mailing list. We advertised in trade journals.

Q. I show you "Electronics" of October, 1930. Look at page 22. Is that your advertisement (handing to witness)?

Mr. Ashton: That is a long time after the suit was brought, your Honor.

The Court: Yes.

Mr. Berliner: It involves knowledge, your Honor.

The Court: They began suit eleven months before this.

Mr. Berliner: On the good faith of this suit, this suit has been pending for over five years.

The Court: I think I will exclude an advertisement of October, 1930.

Mr. Berliner: May I have an exception.

The Court: Yes.

The Witness: The catalogue you show me now was issued by my company. I cannot give any definite date on this.

Mr. Berliner: If I may refresh the wit-

Charles L. Loughead--For Defendant--Cross.

1045

ness' recollection, this refers to 1930.

"During the year 1930, panels for more than 1,000 systems were supplied." This must have been issued in 1931.

Mr. Ashton: I object to it for the same reasons, your Honor.

The Court: Same ruling.

Mr. Berliner: Exception.

The Witness: During the period that I was president of the company, I do not remember that my company sold any amplifiers to the Western Electric Company, just by itself. The Western Electric Company was a customer of our company and I have no doubt it was on our mailing list, but I don't know.

1046

Mr. Ashton: I will move to strike that question out also, your Honor, later, if that is directed to bringing in the circul-lars that we were talking about before.

The Witness: Our company was never sued by any of the plaintiffs in this action or by the R. C. A. for a violation of this license agree-ment and was not sued by them or any of them for any reason that I know of.

1047

Cross Examination by Mr. Ashton:

I joined the American Transformer Company about the middle of June, '29, just about a month before I signed this first letter, Exhibit J, which is dated July 16th. I do not know if the original of the paper you show me is in court. I don't know if the paper you now show me is the origi-nal. I have not read this thing through since

1048 *Charles L. Loughhead—For Defendant—Cross.*

the date of it, four and a half years ago. Well, I would assume it is the original. I don't know. I cannot say whose handwriting it is in the upper right hand corner. It is not mine.

Mr. Ashton: It states that this memorandum was prepared by M. Schlesinger, but not authorized to be sent by the American Transformer Company.

1049 The Witness: As far as I know Mr. Schlesinger was president of General Talking Pictures Company. I think this draft was submitted after I had talked to him and his brother in his office, but it is not clear in my mind. However, I think that is correct. That is my best recollection. I do not remember this letter in my files and I do not know that it came from the files of the American Transformer. Assuming that I am correct in thinking that this conversation which I had with Mr. Schlesinger was prior to July 3, 1929, the date of this memorandum; that is the only thing I have to date it.

1050 I took this draft of the letter up or the letter I wrote with our attorney, Mr. Lum. I am not certain as to whether this was taken up with him first or not.

The paper you now hand me and which you say is a proposed letter dated July 16, 1929, is the same as Exhibit J. It is quite a lot to read through.

By the Court:

Q. By looking at the paper that you have just seen, dated July 16, 1929, are you able to say where that paper was typewritten? Is there anything on the paper that suggests to you where

Charles L. Loughhead—For Defendant—Cross.

1051

it was actually typewritten? A. The word "pictures" in the address that appears at the top of the first sheet looks somewhat like my writing. That is as near as I could come to it. That might be mine, although I don't always write the same.

By Mr. Ashton:

I never said that I know of this yellow-pencil memorandum attached to these other papers I have been looking at. It is not my writing and do not know whose writing it is. I cannot say that I have any idea whose writing it is. This writing in the upper left hand corner of the paper you are showing me, the letter of July 10, 1926, is not my writing and I have no idea whose writing that is.

1052

In my conversation with Mr. Schlesinger I don't remember discussing with him the preparation of such a letter as Exhibit J.

Q. But you recall now, do you not, that this draft of July 3, 1929, was probably submitted to you by Mr. Schlesinger? A. Yes, I think so. I could not account for it in any other way.

1053

Q. You could not account for it in any other way? A. Oh, by Mr. Schlesinger?

Q. Yes. A. Oh, not by Mr. Schlesinger. I do not know who submitted it, but that is evidently a draft on which my first letter was written.

By the Court:

Q. The word "that" is not clear. What do you mean, that that is a draft of something? A. This is dated prior to my letter.

Q. What do you mean by "this"? "This" and

1054 *Charles L. Loughead—For Defendant—Cross.*

"that" do not mean anything. A. This draft of July 3rd I undoubtedly had before me when I wrote my letter of July 16th. The coincidence is too great.

By Mr. Ashton:

Q. There is no doubt about that, is there, Mr. Loughead? A. I would think it is true.

Q. I want to get this very clear. You seem to have remembered some of these things pretty well. Really, isn't it true that this draft of letter and my conversation and so on were all pretty well thought out? A. No, sir; I cannot agree with you. It may have been, but I don't remember that it was.

Q. I would like you to tell me exactly how this letter happened to be sent over to you. A. I did not remember how the—

Mr. Berliner: I object to the statement "happened to be sent over to you." It was not sent over to him.

1056

Mr. Ashton: He says it was submitted to him.

Mr. Berliner: That is not testimony, and I move to strike it out.

The Court: I think that objection is sound. Reframe your question.

The Witness: I cannot tell you how the proposed letter of July 3, 1929, got into the files of our company. I said that my letter of July 16, 1929, Exhibit J, and the one of July 24th, Exhibit K are based on it because the phraseology is the same in several paragraphs. I don't

Charles L. Loughead—For Defendant—Cross. 1057

think the phraseology in this letter is mine. Well, I saw it in your office. That is the first time I saw it. I don't think I am the author of that letter. I am sure I am not the author.

Q. If you were not, was anybody else in your company as far as you are able to know— A. No, I am quite sure there was no one else in our company. I do not know who the author was.

Mr. Ashton: I am asking the witness to state the difference between the two letters of July 16th and 24th, as compared with this draft here. There are no material differences in the two letters of July 16th and 24th so far as the plaintiffs are concerned.

The Witness: I have not seen this in four years and a half, and it is a little hard.

Q. I wish you would read it, Mr. Loughead, to yourself. A. May I have the letter of the 16th?

The Court: Yes, here it is (handing witness).

The Court: The difficulty that you are laboring with, of course, is that you have not this proposed letter of July 3rd either marked for identification or in evidence. That is your point, isn't it?

Mr. Ashton: Of course I shall offer it later on. I ask that the letter of July 3, 1929, be marked for identification Plaintiffs' Exhibit 29.

(Marked Plaintiffs' Exhibit 29 for Identification.)

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1059

1060 *Charles L. Loughead—For Defendant—Cross.*

Q. You have the question in mind, have you?
A. The question is what the differences are?

Q. Yes. A. In the first paragraph we did not state that the Western Electric Company.

1061

Mr. Berliner: Your Honor, I object for two reasons: in the first place the July 16th and 24th letters speak for themselves and are in evidence; in the second place the draft certainly is not admissible, not because it is marked for identification but because it refers to antecedent negotiations which were finally embodied in a consummated agreement, and it cannot be argued that prior negotiations are admissible in evidence to show what the subsequent conclusion of those negotiations really amounted to. The draft is conceded to be a draft.

1062

Mr. Ashton: The point is that Mr. Loughead would not send out this letter the way it was submitted to him, and we want to show—

The Court: The fact is that he did not send it.

Mr. Ashton: But the draft. The point is that he had not seen the original draft the way it is submitted. That is the reason for the questions and the comparison. I am going to ask him when he points out the difference why he left that out.

Mr. Berliner: It is not admissible in evidence, your Honor.

The Court: That is argumentative. It is perfectly plausible that the spoor of the letter writer may be disclosed in Exhibit

Charles L. Loughead—For Defendant—Cross.

1063

29 for Identification. The consideration of one dollar, and so on, that never originated in the mind of the layman, you know:

The Witness: I do not recollect why I did not state in the letter of July 16th or in the letter of July 24th that "we manufacture such amplifiers without infringing any patents of any kind whatever in the United States," except that I would never write such a thing for anybody. Neither would the Western Electric Company.

1064

Mr. Ashton: I want to know why he left out these two or three things.

The Court: Yes, you want to know why he left out certain things, and I do not see how you can really get that in any comprehensive form unless you read the contents of the letter, and I am not going to let you do that—read that into the record. It is quite clear that the letter sent was not the letter as drafted. Can't you go on from that point?

1065

Mr. Ashton: With your Honor's leave I would like to ask the witness why he did not make this particular statement that is at the end of that first paragraph of the letter.

The Court: I want to suggest to you, without participating too much in your case, that the only way you can do it is to ask, why didn't you make any statement covering so and so.

Q. Why didn't you make the statement that they, referring to the Western Electric Com-

1066 *Charles L. Loughead—For Defendant—Cross.*

pany, have examined one of the amplifiers which

The Court: I will ask you, Mr. Ashton, to adhere to my ruling.

Mr. Ashton: I am sorry, I imagine I do not understand your Honor.

The Court: You may ask the witness, why didn't you make any statement covering such and such a general subject. You may not quote from this paper.

1067

The Witness: I did not make a statement in the letter that representatives of the Western Electric Company had examined one of our American Transformer amplifiers and had made no objection to it, because I could not make it of my own knowledge.

Mr. Berliner: Is that question directed to the draft?

Mr. Ashton: Yes.

Mr. Berliner: If so, I object to it.

The Court: It is directed to a subject and not to the letter at all.

Mr. Berliner: Mr. Ashton did mention the letter.

The Court: The answer is that he did not mention the subject in Paragraph 5 of Exhibit J.

The Witness: Paragraph 5.

That statement does not appear in the letter of July 16, 1929, Exhibit J; I said we have been informed, I think, as I remember reading it just now. That is the difference. Because I was in-

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Charles L. Loughead—For Defendant—Cross.

1069

formed, and I cannot say definitely. I did not know it. This paragraph 5 of Exhibit J, the letter of July 16, 1929, does not appear in the letter of July 24, 1929, Exhibit K. I don't know why I left that out. It is my recollection that this letter of July 24, 1929, Exhibit K, was supposed to take the place of the letter of July 16th, but what I remember is this other. My final arrangement was this one of July 24, 1929.

Q. You stated I believe that when you talked with Mr. Young of the Western Electric Company you were talking about something else. A. Yes, sir.

Q. Other than the question of supplying amplifiers. Is that right? A. No, not the question of supplying amplifiers, but something different from the matter of General Talking Pictures.

Q. Yes. A. No, I was talking about supplying amplifiers.

Q. You were trying to get the right to supply them; is that it? A. Objecting to the fact that we had to compete with about three hundred people who had no licenses and we were paying a license fee.

1070

This recent license which I said that my company was negotiating to get from the Western Electric Company has to do with phonograph music reproduction, and does not include talking motion pictures. I don't think it specifically includes it. I don't remember that it expressly excludes them, but very likely. I am not quite sure about that.

1071

Mr. Berliner: Mr. Ashton is testifying as to what the proposed license agreement includes or excludes. I think that is improper.

1072

Charles L. Loughead—For Defendant—Cross.

The Court: I think he has a right to ask him on cross examination.

Mr. Berliner: I do not object to his asking him, but I don't want Mr. Ashton to do the testifying; that is for the witness.

The Court: I think that Mr. Ashton merely wants to clarify the situation.

1073

The Witness: The Mr. Young I mentioned, is Mr. Harry E. Young, connected with the company. He was the commercial engineer. I don't know if he was an officer of the Western Electric Company. In 1929 I brought to the attention of General Talking Pictures Corporation, the license agreement which we had with the Radio Corporation and which is Exhibit E in this case. I called attention to the provisions of that license relating to restriction of the right to manufacture and sell.

1074

Mr. Berliner: Your Honor, he is giving the questions and answers, without giving the witness a chance to answer, and I object to that line of questions, and I ask that the question be stricken out.

The Court: Well, both counsel have been doing that right along. Tell me, Mr. Ashton, what did you mean by your question, "You brought the license agreement to the attention of the General Talking Pictures Corporation"; that is not clear to me.

Mr. Ashton: I am trying to find out, your Honor, if at the time of these conversations which the witness has referred

Charles L. Loughead—For Defendant—Cross. 1075

to between the president of the General Talking Pictures Company and himself, whether or not Mr. Loughead actually brought the license agreement, the written license agreement to the attention of Mr. Schlesinger.

The Court: Did you mean to ask him whether he showed the agreement or whether he talked to him?

Mr. Ashton: Maybe both, your Honor.

The Court: Ask him, that is what I 1076 want to find out.

I did not show Mr. Schlesinger the license agreement, but I did give him the terms of it in a general way, and we talked and discussed the restrictions and limitations.

By the Court:

I told him we could sell with that license plate on stating what those restrictions were and I told him what the restrictions were. I cannot say whether I told him that from any memorandum I looked at or from what I recalled of the language of the license. I think before that came, there was a letter sent to him which gave that.

1077

By Mr. Ashton:

At that time I knew the provisions of the license very well.

The Court: You mentioned incidentally, what might be an important fact, namely,

1078 *Charles L. Loughead—For Defendant—Cross.*

that Mr. Schlesinger was the president of the company; is that the fact?

Mr. Berliner: That is the fact.

The Court: And was the fact in July, 1929?

Mr. Berliner: Yes, and in 1929.

The Court: I am glad to know it.

The Witness: This, which you hand me, is a license plate of the type which we placed upon the amplifiers which we sold.

1079

Mr. Ashton: I ask that the license plate be marked for identification as Plaintiffs' Exhibit 30.

Mr. Darby: Let us look at it; maybe you can put it right in evidence; we have no objection to its being offered in evidence if you want to offer it.

Mr. Ashton: I will offer it when we come to it.

(Marked Plaintiffs' Exhibit No. 30 for identification.)

1080

The Witness: The photostat you show me appears to show a panel of audio amplifiers manufactured by my company. I am not an engineer, so I cannot be certain of this. It has a name plate on it, as far as I can tell, it has. These notices are placed conspicuously on the amplifier. I cannot say whether on the back of the amplifier.

Mr. Ashton: I offer the photostat referred to by the witness for identification as Plaintiffs' Exhibit 31.

(Marked Plaintiffs' Exhibit No. 31 for identification.)

Charles L. Loughead—For Defendant—Cross. 1081

The Witness: I do not know whether my company received a letter dated November 17, 1928, signed by General Talking Pictures Corporation addressed to the American Transformer Company. I was not there at the time; I have no way of knowing. I have some recollection of seeing such a letter in the files, but I could not identify it. I have not seen it recently. I have seen the letter signed American Transformer Company, dated November 23, 1928, addressed to General Talking Motion Pictures, which is attached. I do not know whether that letter was sent or by whom. I can tell by the initials who dictated it. This was six months before I arrived on the scene.

1082

Mr. Ashton: I ask that the first letter referred to, dated November 17, 1928, by General Talking Pictures Company to the American Transformer Company be marked for identification.

(Marked Plaintiffs' Exhibit No. 32 for identification.)

Mr. Ashton: And the letter of November 23, 1928, from American Transformer Company to General Talking Pictures.

1083

(Marked Plaintiffs' Exhibit No. 33 for identification.)

The Witness: I remained active with the company until from about the middle of June, 1929, until about the 1st of November, 1932. From the time I became president of the company until the license from the Radio Corporation expired I was active, except for my health, except that I was away for a period of three or four months. I was away when the company was asked to sup-

1084 *Charles L. Loughead—For Defendant—Cross.*

ply the list of customers to whom we had sold amplifiers.

Q. Do you remember the facts as to the refund of royalties by the Radio Corporation for amplifiers which they found you had sold outside the scope of the license, after you sent them the first list of licensees on December 7, 1929?

A. Yes, sir, I was there then.

Q. And you received refunds, did you not?

1085

Mr. Berliner: I object to that question, because refunding of royalties for any reason whatsoever, certainly is not binding on the purchasers of the amplifiers and licensees.

The Court: I cannot pass on the weight of the evidence until I know what the evidence is.

Mr. Berliner: They asked if they got refunds.

1086

The Court: You proved that payments were made for making certain sales by licensees and I think it is equally competent for the other side to prove what happened to those payments, for what it is worth. It may not be worth anything, but I would like to know the facts.

Q. You know, do you not, that refunds were made for all amplifiers that were sold outside the scope of the licenses? A. I know that refunds were made for what the RCA said were sold outside the scope of the licenses.

The Court: Give us the dates, Mr. Ashton.

Mr. Ashton: Do you want me to go through all the dates on all of these?

The Court: Why don't you gentlemen go and make the schedules of the refunds and put it in tomorrow?

Mr. Ashton: It is all in the binder, your Honor, that we have here, and which was offered in evidence.

Mr. Berliner: Not in that binder; I did not offer that in evidence.

Mr. Ashton: The royalty reports are all in this Exhibit L, and there are several letters in addition; those and some checks which show exactly what the refunds were and when they were made, and I can read them off in a few minutes, either now or tomorrow morning. It will probably save time if I do it tomorrow morning.

1088

The Court: I think you gentlemen can agree upon it.

Mr. Darby: There is no dispute about it, but Mr. Ashton is laboring under a misapprehension when he says that they are included in this exhibit. They are not.

1089

Mr. Berliner: There is a schedule of refunds. There is no dispute as to the fact, but we object to the relevancy and admissibility of it.

Mr. Ashton: We will offer it tomorrow, your Honor. That will simplify it.

The Witness: In making these refunds, the Radio Corporation selected the names of the talking picture people that appeared on that list.

The Court: And only those?

Mr. Ashton: And only those, the others being obviously proper sales for amateur radio purposes.

1090 *Charles L. Loughead—For Defendant—Cross.*

Mr. Berliner: May I enter an objection to that statement by Mr. Ashton? If he submits his schedules, I do not object to them as factual evidence, but I do object to their admissibility.

The Court: Perhaps you do not realize that I asked the question whether the refunds referred only to those particular accounts, and he said yes.

1091

Mr. Berliner: There is nothing in the schedules which cover that in that language and that is the reason I rose to object.

Mr. Berliner: The first refund referred to is the check of the RCA and is dated December 9, 1930, of which I have a photostat here, served by the plaintiffs themselves.

1092

Q. Can you tell me, Mr. Loughead, what is the earliest date that you received any word from the Radio Corporation of America as to your sales outside of the scope of the license? What is your best recollection of the date that you first heard of their objection? A. I have no recollection of anything prior to the letter accompanying the checks.

Q. Are you sure about that? A. I am sure I have no recollection, yes, sir.

Q. You have no recollection. You don't remember receiving calls from Mr. Anderson of the Radio Corporation? A. I do not think he ever called on me in Newark.

Q. Or telephone messages? A. I don't remember that. I saw him in New York, but I never saw him in Newark.

Charles L. Loughead—For Defendant
Re-direct.

1093

Re-direct Examination by Mr. Berliner:

The Court: Then, these details about the refunds you gentlemen can agree on?

Mr. Berliner: I have them here as submitted to me by Mr. Ashton. They are absolutely correct factually; I just enter my objection to their admissibility.

Mr. Ashton: I will offer them in the morning as our exhibits.

1094

Q. Mr. Loughead, when you stated to Mr. Ashton on cross examination that you talked to Mr. Young and that you did not go to see him about General Talking Pictures, is it not a fact, nevertheless, that you did talk to him about General Talking Pictures Corporation? A. Yes.

Q. And your sale of amplifiers to the company? A. Yes, sir.

Q. And he did not object? A. Yes, sir.
Before sending the letters of July 16th, July 24th, 1929, I think I did tell Mr. Schlesinger, at the conferences with him, that I had a right to sell his company those amplifiers.

1095

From June, 1929, when I came to the American Transformer Company until I left the company in 1932, my company was bidding with other licensees of the RCA in the same field for the manufacture and sale of amplifiers.

Q. And were those other companies offering amplifiers for theatre reproduction purposes as well as in the open market?

Mr. Ashton: I don't think it makes much difference what other companies were offering.

1096 *Max A. Schlesinger—For Defendant—Direct.*

The Court: Are you objecting, Mr. Ashton?

Mr. Ashton: Yes, sir.

The Court: Please state your objection.

Mr. Ashton: What other manufacturers of amplifiers were offering for sale, seems to have no bearing on what this company was offering for sale or as to any other matter in the case.

Mr. Berliner: Certainly it has a bearing as to the course of practice and procedure of which plaintiffs had knowledge and RCA had knowledge, that the whole market was selling—

Mr. Ashton: It could have no bearing on this case—

The Court: I will agree with you if you give me a chance to rule. I will sustain your objection.

Mr. Berliner: Exception.

The Court: Now, to save time, don't waste much time on the talk with Mr. Young and no objection being made, because I regard that as quite an indefinite conversation.

Mr. Ashton: Yes, your Honor.

MAX A. SCHLESINGER, called as a witness on behalf of the Defendant, being first duly sworn, testified as follows:

Direct Examination by Mr. Berliner:

I reside at the Savoy-Plaza Hotel, New York City. I am a lawyer by profession, but in recent

Max A. Schlesinger—For Defendant—Direct.

1099

years have devoted my time exclusively to commercial enterprises. I have been president of the defendant General Talking Pictures Corporation since its organization in September of 1928.

The business of that corporation is the leasing of recording and reproducing equipment for talking motion pictures to theatres in the United States. I came to organize this corporation in that I was interested in theatres and the amusement business generally, and saw the change from the silent picture to the talking picture, and was acquainted with a man by the name of Dr. Lee De Forest, who was then operating a company called the De Forest Phonofilm Corporation, engaged in the manufacture and leasing of recording equipment for talking motion pictures, and for reproducing equipment in the same field.

I saw exhibitions of the pictures produced by that company, in New York City, in about 1923. Between 1923 and 1924 and 1925. I believe the first one I saw was at the Rivoli Theatre, in New York.

I organized the General Talking Pictures Corporation, and that company took over the De Forest Fonofilm Corporation. At the time I took it over it was the only one that had talking picture reproducing equipment installed in this country. They had installed about sixty or seventy equipments. At that time they had also produced and on hand talking motion picture films. A great many of them; yes, sir. They continued in operation down to the time General Talking Pictures Corporation took them over.

Before I organized General Talking Pictures Corporation in about September, 1928, I con-

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1102 *Max A. Schlesinger—For Defendant—Direct.*

sulted patent counsel, who was then acting for Dr. De Forest—Messrs. Darby & Darby, particularly Mr. Samuel E. Darby, Jr.—and had several conferences in connection with the talking picture business. I also discussed the question of the use of amplifiers manufactured by licensees of the Radio Corporation and had an opinion rendered by Mr. Darby on the subject before I organized General Talking Pictures Corporation.

This is a letter I received from Mr. Darby in
1103 connection with that subject matter.

Mr. Berliner: I offer it in evidence.

Mr. Ashton: I think, your Honor, that it is proper the witness should state that he consulted counsel. However, I do not think that counsel's opinion is proper evidence, and I therefore object to this opinion, which of course I have not read. The only possible bearing on the case as far as I can see is that Mr. Schlesinger claims that counsel told him to go ahead and make these amplifiers.

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The Witness: Not make them.

Mr. Ashton: Weil, purchase them.

Mr. Ashton: I do not see that the opinion really has any bearing on it at all, but simply that he was advised by counsel.

Mr. Berliner: May it please the Court, we do not offer it to prove as a legal fact, which is for your Honor, that he had a right to purchase them but that he was so advised; and under a decision of the Circuit Court of Appeals, for the Third Circuit, opinions of counsel in such matters are admissible.

The Court: For what purpose?

Mr. Berliner: To prove good faith, and that he acted in reliance on it and not with any malice or intention to infringe.

The Court in the Third Circuit stated that it also goes to the question of estoppel, because the argument there, as I recollect it, is that if counsel was consulted by the defendant alleged to infringe, it is likely that the same question must have been up before the plaintiffs, and the Court holds that such testimony as to advice is admissible,—not to prove the fact, but that he acted on the advice. The citation is 64 Fed. (2d) 185.

The Court: What did you mean by the expression "that fact, that something had been before the plaintiff?" That is what I want to know and what I find difficult to follow.

Mr. Berliner: I am merely paraphrasing what the Circuit Court of Appeals stated there,—that the advice was sought and taken by the defendant, is indicative of the fact, not proof, that the plaintiff itself must have considered this question and possibly have passed upon it. However, we need not go as far as that. It is purely on the good faith of the defendant in seeking advice before embarking on an enterprise relating to patents. We do not offer the letter as proof, as a question of law, because that is for your Honor to decide.

The Court: I would like to read Mr. Darby's opinion, but I do not think it is

1108 *Max A. Schlesinger—For Defendant—Direct.*

a competent part of your proof. I will sustain the objection, with exception.

By Mr. Berliner:

The Witness: I took up with Mr. Darby the matter of our right to purchase amplifiers manufactured by a licensee of the plaintiffs and the Radio Corporation of America. He advised me that the equipment manufactured legally under a license can be bought by me, if sold in the open market, and I can disregard any restrictive notices on the equipment itself, and use it for any purpose I desired. That conversation was had and that advice was given about in August of 1928, about a month before I organized the company.

After I organized the company and before February 4, 1929, I used amplifiers for talking picture reproduction purposes manufactured by the American Transformer Company. In the gubernatorial campaign of 1928, shortly after I organized the company, Governor Smith was the only candidate for Governor who could have talking pictures publicly in the streets of New York. A novelty was presented in talking pictures for the candidate in the public streets, and the Republican authorities came to me and said they could not get any talking pictures because Governor Smith had them all tied up, so I made a picture of the candidate, Mr. Ottinger, and a speech by him and had it go on a truck through the City of New York, using the American Transformer amplifier. I bought that amplifier from a company called the Phototone Company, who, in turn, had acquired it from the

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American Transformer Company. I acquired several other amplifiers from the Phototone Company before that period. It was early in the stage of talking pictures, as now known. There were not as many theatres equipped with them as now.

Before I organized the defendant company, De Forest Fonofilm Corporation, its predecessor, was the only company that had installed talking motion picture apparatus in theatres throughout the country, in the sound on film system, as distinguished from sound on disc.

Before February, 1929, I had several conversations with representatives of the plaintiffs. I talked to Mr. Otterson, who was then, I think, vice-president of the Western Electric Company. This was in 1927, at his office, 195 Broadway, I believe that is the address of the American Tel. & Tel., and I met Mr. Drake at that place. I understood he was second to Mr. Otterson, for the purpose of my interview with him.

I had several talks with both Mr. Otterson and Mr. Drake again after I organized the General Talking Motion Pictures Corporation. We had several negotiations proposed, one in connection with talking motion picture equipment for foreign countries and others for talking motion pictures for South Africa generally, besides foreign; thirdly, a proposal to merge the patent situation that they contended they might have, as against those that I contended I had in the motion picture field. Dr. De Forest has from the inception been connected and still is connected with my company. We talked about the motion picture business in America and the probability and desirability of having motion picture pro-

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1114 *Max A. Schlesinger—For Defendant—Direct.*

ducers of silent pictures undertake to go into the new field. We talked about my entering into the field, and after I had entered into the field, I again talked to them and told them how I progressed in it. I told them the equipment I was developing and my proposal to lease them, buy the goods in the open market and assemble them and then lease them to the theatres, and they asked me, "What are you going to do about an amplifier?" I said "I would like to buy them from you."

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They said that was rather a question; that they were using theirs for their own purposes; that the theatres were making a great demand for equipment; that they could not get the equipment fast enough for the growing industry, and I told them I had in 1928, around the campaign, obtained one of their licensed amplifiers, and I could get a supply of them.

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I am just trying to recollect the incidents, they came so fast and furious in those days, and it is so far back. I am trying to do the best I can. Well, particularly after my return from a European trip, and about the time that Mr. Knox, another of the officials of the Western Electric Company or Electrical Research Products Corporation was about leaving for England, Mr. Knox called on me at my office and we had a talk about the amplifier that I was using, and he said, "You are lucky to have a licensed amplifier." I told him I was getting it from the American Transformer Company. I told Mr. Otterson that I was getting it from the American Transformer Company. He said to me, "We are more concerned with the true

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reproduction obtained, so that the art is not impeded by the poor reproduction you get from bad sound."

By the Court:

Q. Excuse me for interrupting, but you will have to fix the time for this. A. That was in 1927, in the Fall of 1927, and again in 1929, on my return from Europe.

Q. Speaking of your conversation with Knox, was that again in 1929? A. That was with Otterson again in New York in 1929.

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By Mr. Berliner:

I had a conversation with Mr. Otterson before I went to Europe in 1928 and discussed the amplifier that I was using in the campaign.

By the Court:

Q. What time was this in 1929, please? A. First I am talking of 1928, if your Honor please, in the campaign of 1928.

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By Mr. Berliner:

That was in the Fall of 1928. In the Fall of 1928 I merely told Mr. Otterson that I was able to procure an American Transformer amplifier for the campaign, and was discussing with him the possibilities of the Western Electric selling me more amplifiers. He said that he had known of the good work of the American Transformer amplifiers; he thought the amplifiers, as reported to him, were good amplifiers; that it was

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a licensed amplifier, from one of their licensees. He did not object to our purchasing and using it.

By the Court:

That conversation was not directed particularly to the campaign. We had discussed several subjects under consideration, as I outlined a few minutes ago. I am speaking now of the Fall of 1928. We discussed several matters.

1121 By Mr. Berliner:

We discussed the proposal of their company to sell equipment for theatres in South Africa, which I was to buy in America for the South African firm; also the possible exchange of licenses under patents owned by them and patents owned by me, and in addition to that, what I was doing in America with my American patents, the American De Forest patents.

1122 Q. In the year 1929? A. In other words, I kept Mr. Otterson closely advised of what my company was doing, because we had it in mind that ultimately a connection would be arranged between the two companies.

The Court: We are still in the Fall of 1928. You appreciate it is very important that you should state what was said and you should not characterize the nature of your interviews. As a lawyer, you must appreciate that.

The Witness: In the early part or between January and February of 1929, I met Mr. Otterson again in New York, this time at the uptown

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office of the Electrical Research Products Corporation. I think in the Fisk Building, 57th Street, New York. No one else was present. There were several subjects up for discussion, among others—I told him that since I was back from London, I could get control of the German patent situation; that, together with the British patent situation which I controlled, and the American situation which I controlled, would call for a trade agreement, and I discussed also the possibility of a combination or purchase of my interest by them. He said that he was interested in anything along the progressive lines of business, and had made studies into our patent situation through his counsel and our counsel and deliberations were going on from time to time, but at this particular meeting at his office, he said, "Well, how are you getting along in your American business?" which he did from time to time, and particularly, on that occasion I remember I said, "I am getting along very well. Business is growing very fast, and I have struck a very fine amplifier. They are making it practically for me alone, as I understand it, my particular model, and other models of a similar kind they are making for a few others." He said, "Are you still having the American Transformer Company supply you?" And I said, "Yes," and I said, "That is a funny situation; as a competitor, I am paying you royalties out of my business," and we both laughed, and he said, "It's funny." I don't want to bind myself to the exact words, but that is substantially what happened.

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In the early part of 1929, until about June or July of that year, I had been buying ampli-

1126 *Max A. Schlesinger—For Defendant—Direct.*

fiers regularly for talking motion picture purposes from the American Transformer Company. I had been doing that on the advice I had received from our counsel Mr. Darby.

Q. Do you wish to add—was any further conversation had with Mr. Otterson or any representatives of his or the plaintiff companies before July, 1929? A. Merely that several representatives, such as Mr. Palmerton—

1127 He is engaged in the company in some capacity of selling equipment for talking motion pictures. Mr. Gregg is the name of another man I met, who called on me and discussed the possibility of our buying equipment for talking motion pictures from them,—not amplifiers alone,—for South Africa, and while in my office, I said, "It is strange that I should be buying equipment from you for South Africa, and assembling equipment here for the American industry." Mr. Palmerton stayed there for quite a length of time discussing my American business, and naturally I discussed with him the salient features of the equipment, which is the sound head and the amplifier. I told him about the amplifier I was using. I told him I was buying them and paying a price that was far less than the price they were charging me for South Africa. I said the American Transformer Company was charging much less than they charged for Africa, and that the price for the equipment for South Africa was inconsistent with the price that I was getting from the American Transformer Company. There was a discussion of the price I was getting for export, and the price I was paying for the domestic market. I discussed that with Mr. Drake, Mr. Otterson, Mr. Palmerton, Mr.

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Gregg and Mr. Knox. The result was that I was unable to purchase for foreign countries, because of their price.

By Mr. Ashton:

Q. I understood you to say that this was before July, 1929, can you be more definite than that? A. Yes. There was a time when Mr. Otterson went over to Europe, and it was after his return from Europe in 1930—let me get my dates fixed—after his return in 1929, we both had been there at separate times—will you let me refresh my recollection for a moment, because there were so many trips I made at that time.

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By Mr. Berliner:

Q. Yes, just consider it a moment. A. Yes, there were several talks I had in February of 1929.

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Q. If you cannot fix any particular month, just do the best you can, that is all. A. Well, fixing it by the time there were so many negotiations between the Western Electric, Radio Corporation, myself and the German Patent Control—they visited here and we visited abroad, and in the course of these deliberations we also discussed the prices of equipment, and we never did buy the equipment for South Africa.

Q. In other words, you do not remember what period of 1929 it was? A. I cannot give the exact dates in 1929. I travelled a great deal both here and abroad, and I did not have any diary.

Mr. Otterson told me that as long as the reproduction was not affected there was no ob-

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Max A. Schlesinger—For Defendant—Direct.

jection to everybody going into the field, and wanted to keep bootleggers out who did not want to make machines that would reproduce honestly and accurately from the recordings of their licensees in motion pictures. All they could have talked about was the amplifiers.

Mr. Otterson told me that he had spent endless time and money in trying to educate the manufacturers of motion pictures in the silent field to enter upon the recording business in talking pictures, and that he was particularly interested that people would use the amplifiers

1133 that would reproduce properly and accurately, and the American Transformer Company, he told me, was one of those who made a high-class amplifier. He did not object to it. On the contrary, he encouraged us to use it.

The Court: Instead of saying, "he encouraged us to use it," if you will say he stated thus and so you will help me.

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The Witness: I would rather put it, if your Honor pleases, that I told him how I had engaged in the pineapple industry, which is foreign to this, and that it was a new industry in South Africa, and that when I attempted to find out how to operate the pineapple industry in South Africa I went to Hawaii and I was amazed to find that the Hawaiian Pineapple Company was ready to offer every aid and assistance so long as their advertising of canned pineapple, which they spend so much money on, to induce people—

Mr. Ashton: I do not think this has very much to do with this case.

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The Court: I suppose I have opened the floodgates. I asked for the conversation. Now, I am more interested in what Mr. Otterson said to you; preferably about amplifiers.

The Witness: That it had a comparative value—He said, "You go along, and competition is healthy, and as long as you turn out a good equipment I have no objection to it," which meant the taking of a good amplifier and the rest of our equipment.

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By Mr. Berliner:

Q. Did you tell him that you were purchasing amplifiers from American Transformer? A. I naturally have testified to that.

Q. Did he object to your purchasing and using it? A. He did not. He said as long as the royalty is paid it is quite all right. This all occurred before July of 1929.

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From the Fall of 1928, when General Talking Pictures Corporation was organized, until about the Summer in June and July of 1929, I also had conversations with officers of the Radio Corporation of America, one of the licensors, Mr. David Sarnoff and Mr. Bucher. Mr. Sarnoff was president of the Radio Corporation of America; or managing director, I don't know. One of the high officials in the Radio Corporation of America. I also talked with Mr. Sawyer and Mr. Bucher. Mr. Sawyer was one of the vice-presidents of the R. C. A. Photophone Corporation, a subsidiary of the Radio Corporation of America. Mr. Bucher was also one of those vice-presi-

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dents. They had several of them. During the same period of time that I was negotiating with the Western Electric I was also negotiating with the Radio Corporation for the purchase of equipment from them. I was finding difficulty in getting equipment from them, because they were holding back the supply, and unless I had their equipment I could not get any pictures, so that I had to go between the two only competitors there were, between the Radio Corporation and the Western Electric for equipment and for pictures. The conversations were on the purchase of my patent rights by the Radio Corporation, their investigation into what patent rights I had, through appointment of their counsel meeting my counsel, and their ascertaining what I was then using, and amongst other things in the use of our equipment the amplifier came up. Mr. Sarnoff said to me, the American Transformer Company—told him I had bought from the American Transformer Company the amplifiers, which his people had known through investigation,—and he said, "Well, they are a licensed firm, and that is all right."

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Q. Did you have any further conversations with him concerning the amplifiers or anything else connected with your business? A. Not specially the amplifier, but the amplifier came up in the discussion of the various businesses that we had before us.

Mr. Sarnoff was never personally in the factory or the studio of the General Talking Pictures Corporation, but his office sent over their engineers to our studio in order to look our proposition over, mostly from the viewpoint of becoming a co-tenant in the studio and from the

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viewpoint of seeing what we were having to offer. I can place it with Mr. Sarnoff particularly when he went off with Owen D. Young on a mission abroad. It was a public matter at the time. It was about between 1928 or 1927—between 1927 and 1928 is my recollection. I had my talk with him concerning our purchase of the "Amer Tran" amplifiers, in the early part of 1929, because again he was involved in the negotiations about the German patents. I accompanied his representative to our studio. "Amer Tran" amplifiers were installed in the studio in 1929. I don't think a special move to inspect an amplifier, but they inspected all the equipment.

As to the conference with the engineers coming down to the studio, I must be bound by the time that Mr. Sarnoff went on his commission with Owen D. Young to Europe.

The Court: I am interested in what took place when the engineers were present.

The Witness: Well, they took measurements of the studio; they examined all the equipment, both in recording and our reproducing equipment on the premises. The studio was at 318 East 48th Street and 317 East 47th Street—and after they took their measurements they sent word that it was too small and that they wanted to use another studio; that they remarked about the equipment. The American Transformer amplifier constituted a part of the equipment they inspected, amplifiers in connection with the reproducing equipment. I had no others.

Q. You are unable to fix that time any more definitely than in connection with the visit to

1144 *Max A. Schlesinger—For Defendant—Direct.*

Europe of Mr. Sarnoff and Mr. Young; is that it? A. As to those engineers being in the premises.

Q. That is all you can do, to fix the date? A. If I could be given just a moment.

Q. Yes, you will be given all the time you need. A. I fix it in 1928.

By Mr. Berliner:

1145 It was at the end of 1928. That is as near as I can remember. My first connection with the American Transformer direct, as distinguished from Phototone from whom I bought first, was Mr. Zelony, who is the manufacturer's agent of the American Transformer Company. Thereafter through Mr. Zelony I met Mr. Loughead, its president. I also met Mr. Schermerhorn, who I believe is vice-president, at the time. I had talks with Mr. Zelony at my office from February to July in 1929—until I met Mr. Loughead in July the first time.

1146 The first purchases of amplifiers by General Talking Pictures Corporation were in February, 1929. That is what I understand is the date, and I believe that to be true. Mr. Zelony met me in my office, 218 West 42nd Street. He offered to sell me the American Transformer amplifier for theatre purposes in quantities. He told me that they were licensed to manufacture amplifiers and they were paying a royalty for each amplifier they manufactured and sold. He knew the business in which my company was engaged in.

The Court: How does this witness know what somebody else knew?

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The Witness: I discussed it with Mr. Zelony.

By the Court:

Q. State what you said. A. He had been supplying amplifiers to me from the American Transformer Company, and I told him of the urgency of quick deliveries, because the theatres requiring those amplifiers were as the equipment was being installed depending upon specific dates and hours of opening, and the urgency of making quick deliveries to the various theatres.

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By Mr. Berliner:

He told me about the rights of the American Transformer Company to sell amplifiers for theatre purposes. I was anxious to get only amplifiers that would in no way infringe; I was out, or ventured into a business that claimed patents and I wanted—

The Court: We understand your frame of mind. What did he say to you?

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Q. What did he say to you? A. He said to me, "My company is equipped to give you licensed amplifiers, licensed by the Electrical companies, and give you as many as you would want for your requirements for the theatres." And I said, "I have been buying some from time to time, but I am going into this business in a large way and I would like to get a quantity of them assured to me, and I would like to get an option on them to take them up as I require for a year or from year to year." He says, "That would

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not be in my province, I would have to get the president of the company over to see you." I said, "Will you arrange to do that?" And as a result of that he brought Mr. Loughead to my office in July, the early part of July of 1929. My brother, Mr. I. W. Schlesinger, Mr. Zelony and Mr. Loughead were present at that conversation. I reviewed what I had done in business with theatres up to that point, and said it looked like a very large business and I would require several thousands of their amplifiers, provided they are licensed. He said to me, "I have the facilities and am geared up with this American Transformer Company to give you whatever you require in the way of amplifiers." I said, "Well, I want assurances, however, from you that it is manufactured under a non-infringing patent and there is no infringing ~~of~~ patent." He says, "That we have, because we have a license from the Radio Corporation of America and affiliated companies," and I said, "Could you give me as many as two thousand of them if I required them, in a year?" He said, "Yes." I told him I required two thousand because there were rumors in the field that their company having manufactured a very high grade amplifier might be bought by the Western Electric, and I wanted to be assured my source of supply was not cut off right in the midst of my large propaganda in sales. Before I had that talk, I received a letter from the American Transformer Company with respect to these amplifiers. This, which you show me, is the letter in response to my inquiry, proving to me that they were licensed to manufacture the amplifier and that they were paying a royalty of seven and a half per cent.

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Mr. Berliner: I offer it in evidence.

Mr. Ashton: No objection.

(Marked Defendant's Exhibit M.)

The Witness: At the time of this talk with Mr. Loughead I was familiar with the fact that the amplifiers supplied to us by the American Transformer Company had name plates on them and were licensed under the—I discussed that with Mr. Darby before that. I asked Mr. Loughead to give me as many assurances as he can as to the make-up of his business, as to why I would have no trouble in buying their amplifiers; and he said to me, "Of course, you will have no trouble, because our books are open to the Radio Corporation of America under our license agreement, and they inspect our books from time to time and they see from whom we are buying, and they have already seen from time to time that the General Talking Pictures is buying from us their amplifiers." This was about a week or ten days before I received their letter in July, the first letter.

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With respect to the option I desired for two thousand amplifiers, after asking for assurances that the amplifier they sold me for theatre purposes would be all right and I would have no trouble with it, Mr. Loughead went on to tell me at that conference in July, that the books are open to the Radio Corporation for inspection, and where the books disclosed they sell to the General Talking Pictures Corporation and other companies for theatre purposes, and that they pay them a royalty, and that they accepted and no protest has ever been made; and, furthermore, that he, Mr. Loughead, had seen an official

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1156 *Max A. Schlesinger—For Defendant—Direct.*

of the Western Electric who said that he knew about our buying the amplifier from the American Transformer Company, and said it was quite all right.

I said I would like his representations committed to writing, and after a full discussion between Mr. Zelony, Mr. Loughead and myself, at which my brother sat and listened—but did not participate—Mr. Loughead said he would have his lawyer draw them up—draw up a letter or agreement. After waiting maybe a week or ten days I received a letter, I think in the middle of July. No drafts of letters were submitted to me. When I got a communication from the American Transformer it was the first letter, in July of 1929. We did discuss the matter very fully before that letter was sent to me. I did not make any notes; but memoranda were made, notes were made.

I am familiar with the two letters written to General Talking Pictures Corporation by American Transformer, one dated July 16, 1929, and the other dated July 24, 1929.

The Court: You are showing the witness what?

Mr. Berliner: Defendant's Exhibits J and K.

The Witness: The letter of July 16th having been delivered to me by the American Transformer Company by mail—and having read it through carefully, I found that the company had omitted to protect me in case their company was sold out to the Western Electric, and I wanted them to enlarge the option to me to extend to an agreement on their part not to mutually cancel

Max A. Schlesinger—For Defendant—Direct.

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the contract with the Western Electric or their licensors to my detriment and cut off my supply of amplifiers, and I discussed that with Mr. Zelony who called on me after receipt of this July 16th letter. He went to the American Transformer Company, as he said to me he would, and as a result thereof I received the letter of July 24, 1929. I was not to receive two letters, but I was to receive an amendment to the first letter, and all I looked at is that protection, for the option.

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Thereafter, my company purchased substantial quantities of these amplifiers for our theatres—for our theatre requirement, for leasing equipment to the theatres.

Neither I nor my company manufactured or sold any amplifiers for talking motion pictures. When we bought them from "Amer Tran" we leased them with other parts of the talking picture equipment to the theatres.

When those amplifiers were delivered to us by the "Amer Tran" Company they did not have any tubes in them. We bought tubes in the open market from licensees, such as Cunningham, the Radio Corporation, and from any radio stores, small and large, wherever the price affected us; wherever it was cheapest we got them over the counter. We did not buy any tubes other than those licensed. I gave strict instructions to buy nothing but licensed tubes.

I received advice of patent counsel, Mr. Darby, in connection with these tubes as well at the same time as I had about the amplifier. He advised that as long as I bought licensed tubes that I was all right. Those were the only tubes we bought.

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1162 *Max A. Schlesinger—For Defendant—Cross.*

Cross Examination by Mr. Ashton:

My company received this letter you show me, marked Plaintiffs' Exhibit 33 for Identification, dated November 23, 1928, from the American Transformer Company, with a bulletin attached.

I could not identify the letter you have now handed to me, dated November 17, 1928, to the American Transformer Company, and marked yesterday for identification Plaintiffs' Exhibit 32, but I assume that it was sent by Dr. De Forest. I recognize Dr. De Forest's signature. The paper marked Plaintiffs' Exhibit 29 for Identification, which you now show me, does not mean anything to me. I can recollect two letters containing what appears to be the subject matter. I do not recognize this particular document. May I ask, was this an original document?

Q. Yes. A. No, I do not recognize it at all. I do not recognize the handwriting in the upper right hand corner. I don't remember any letters being prepared. I remember a full discussion in my office, and whether or not I prepared any document, as I heard Mr. Loughead testify on the stand, I cannot recall. I may have prepared a document. The American Transformer prepared this letter of July 16th and also the letter of July 24th. They prepared them and sent them to me. But I still say that they may have worked out something in my office at the time. These letters were not typed by me. I do not know where they had them typed. I am not quibbling with you as to where they may have been typed. I am merely saying there may have been a preliminary set of notes made up in my office, and

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Max A. Schlesinger—For Defendant—Cross.

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to that extent I would like to correct Mr. Loughead. But I really cannot recollect.

The Court: Let the record show that Mr. Ashton is talking about Exhibits J and K.

The Witness: The arrangement which finally constituted the letters of the 16th was all worked out in our office. I would not say that this draft, Plaintiffs' Exhibit 29 for Identification, may not have been actually written in our office. May I look at it again? I would like to be able to help out on this. I would go so far as to say that I would not say no. I do not recognize it, though.

I never saw a copy of the American Transformer license agreement with the Radio Corporation and other companies, which is Defendant's Exhibit E in this case, until long after the suit was brought, and when we were preparing to defend it and asked the American Transformer to send me a copy, and they sent me a photostat copy. When we were preparing to defend this—rather recently, quite recently. Mr. Loughead's statement yesterday in his testimony that he explained that license to me must be in error. I think he was in error.

Q. Do you know how and under what circumstances you informed Mr. Darby of the relations of the American Transformer Company and the Radio Corporation under this license, if you did not know about the license? A. I knew about licensed amplifiers. They were talked about in the trade, and well known.

I did not familiarize myself with what the license covered. I am not a patent lawyer. I left that to Mr. Darby. He did not get the informa-

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1168 *Max A. Schlesinger—For Defendant—Cross.*

tion from me. I certainly had nothing to give him in that respect. I did not see all the amplifiers. I saw some of the amplifiers.

The notices such as were on all the amplifiers that were purchased are like the notices shown in this photograph, which you show me.

(Marked Plaintiffs' Exhibit No. 34 for Identification.)

1169 That is what I understood was substantially the form of the license plate. Plaintiffs' Exhibit 30 for Identification, which you show me, is a plate such as was attached to the amplifiers, very likely, yes. I would not take full note of the details, but it is substantially what I saw. I would not look at the notice any more than having noticed it, yes; but as to details I could not say that it is word for word as on that plate. But I assume that if is, as I see it..

1170 I am not enough of a technician, I have not enough knowledge of amplifiers to identify the panel of amplifiers you say are shown in Plaintiffs' Exhibit 31 for Identification as those my company purchased from the American Transformer Company. I see a name plate, but I could not read what is on it.

The Court: Here is a glass, if that will help you (handing witness).

The Witness: Thank you.

A. I think I see "Property of General Talking Pictures," and if that is so, if I read that, then I say that is the amplifier we used, such as are involved in this case.

Max A. Schlesinger—For Defendant—Cross.

1171

I recognize the document which you show as a form of contract of lease, used by my company in leasing talking motion picture equipment.

Mr. Ashton: I ask that that be marked for identification Plaintiffs' Exhibit 35.

(Marked Plaintiffs' Exhibit 35 for Identification.)

The Witness: I purchased tubes prior to September 13, 1929, when this suit was brought in any radio shop, for cash—just the way the runners could run around and get them from the shops. Bland, the radio man, I just happen to remember that, being a strange name, and right near the studio. The manufacturers of these tubes I understood were licensees of Radio Corporation. Cunningham was one of the names. We did not use Raytheon until much later in the stage of our business. I think that came around 1930. I recall Mr. Darby's reference to the license agreement yesterday, March 19, 1929, of the Raytheon Company. I believe I bought the tubes from Raytheon in 1930. I looked in vacuum tube cartons lots of times. I have radios at home, in my office and around the shop and in the factories; I touched them, felt of them. I have seen notices, license notices such as have been referred to here in those tubes,—some reference to license; I could not say similar to the ones you are showing me now, but I have seen the license notices and seen the name "R. C. A."

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Q. The paper which I showed you was a license notice of the Radio Corporation of America, such as is included in the vacuum tube.

1174 *Max A. Schlesinger—For Defendant—Cross.*

You have seen cartons containing vacuum tubes, have you not, with notices such as this one that I read to you now: "Notice. Licensed only to extent indicated on the enclosed instruction sheet" (indicating paper)? A. Casually I have noticed these notices on every box, more or less, and referring to the carton of the Radio Corporation, of the 201A tube, which you show me, I knew they were licensed. What the terms were definitely I could not know, and I did not read.

1175 Q. And you have seen on the base of these tubes, have you not, the words, "Licensed only to extent indicated on carton"? A. I don't think I ever took the trouble to see what it says on the base of these tubes, but I knew there were stamps on it, some markings on it,—on most tubes anyway. I think I have seen some that had no markings, but were on the cartons. I did not stop to read what was on those things.

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Mr. Ashton: Note that the witness is examining the base of the Radio Corporation tube type 201A.

The Witness: I don't think I ever really took the trouble to look at any markings. I knew there were markings on there, but I did not know what it was.

The first purchase General Talking Pictures Corporation made directly from the American Transformer Company was in February, 1929, I believe.

General Talking Pictures Corporation, was formed about September 12, 1928. The paper you show me is a certification by the Secretary of State of Delaware and says that it was Op-

Max A. Schlesinger—For Defendant—Cross.

1177

tober 11, but I believe the certificate was applied for in September. It states, "Certificate of Incorporation of the General Talking Pictures Corporation as received and filed in this Office the 12th day of September, 1928."

I cannot state when I bought from the American Transformer Company the first type A-25 amplifier, which you say includes the types A-36 and PA-39, relied upon in this case. Those figures do not mean anything to me, Mr. Ashton. I don't know how to discriminate between them and the same would be true as regards the amplifier type 41-A. I know that there is involved in this case an amplifier referred to as a power amplifier and one as pec amplifier, but what they really do, I don't know.

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Mr. Darby: This is all stipulated in the record, if your Honor please.

Mr. Ashton: These particular dates are not stipulated. I will show you the record if you wish.

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Mr. Darby: The record is in evidence and we do not contest the accuracy of the record.

The Court: By the record, do you mean the reports that went in evidence yesterday?

Mr. Darby: Yes, your Honor.

The Witness: The letter from the American Transformer Company, Defendants' Exhibit M, dated May 29, 1929, came personally to my attention.

The catalogue which you show me appears to be a catalogue which we issued some time during the course of our business.

1180

Max A. Schlesinger—For Defendant—Cross.

Mr. Ashton: I ask that the catalogue be marked for identification.

(Marked Plaintiffs' Exhibit No. 36 for identification.)

The Witness: Dr. De Forest was and still is connected with our company as chief consulting engineer under a retainer by the company.

Before the defendant's company was formed, Dr. De Forest had three different companies interested in talking motion pictures. They were share holding companies, two of them; one of them was a holding company. De Forest Fonofilm of New York was an operating company; De Forest Patent Holding Company was Dr. De Forest's interest in the De Forest Corporation of Delaware, which owned the patents at the time. The De Forest of Delaware owned the patents; De Forest Holding Company owned De Forest's interest in the Delaware Company, and the De Forest Fonofilm, Inc. of New York was the operating company.

1182

I had seen talking motion pictures exhibited by a De Forest Company as early as 1923. It was the De Forest Company. I knew it only as the De Forest Company. I did not know Dr. De Forest personally at that time. I am inclined to think it was De Forest Fonofilm Company; it was known then merely as De Forest, to me. There were a number of exhibitions of De Forest pictures between then and the time that our company was formed. Those exhibitions were continuous throughout that period, as far as Dr. De Forest's money would last in making pictures, and nobody else made them. Pictures were shown continuously in the theatres

Max A. Schlesinger—For Defendant—Cross.

1183

from 1923 until my company was formed by the De Forest Fonofilm Company as their money lasted. They made a considerable number of pictures, which they reprinted from time to time. It was not as the theatrical business is known now; it was spasmodic, novelty business, very short sound synchronized subjects. They were novelties in conjunction with the show.

Some installation of De Forest talking motion picture equipment remained in theatres when I took the business over in the Fall of 1928.

1184

Our business was continuous from its start in September; we operated continuously to the extent that the industry permitted. Whatever the De Forest Company had to show prior to September, 1928, was limited, compared to what the industry is today. When I took it over, I was revamping the studio and revamping the manufacture of it; until I got ready for an up-to-date first class improved equipment. I did not go out for selling—

By the Court:

1185

Between January and September, 1928, De Forest recording equipment was being marketed by De Forest.

By Mr. Ashton:

This recording equipment was being offered for sale. They had reproducing equipment, but they were not geared up for large sales. I have no knowledge of it ever having been withdrawn from the market during the time I knew Dr. De Forest. I knew him in 1927. I took him to

1186 *Max A. Schlesinger—For Defendant—Cross.*

Europe in 1927, regarding the British interests of De Forest.

Q. I ask you to look at this article in the Daily Exhibitor's Review, Monday, September 27, 1928, and ask you to read it; it is very short; I direct your attention particularly to the part on page 2, after looking at the first page, and tell me whether your testimony would be the same (handing to witness)? A. My testimony is notwithstanding, still the same.

1187 Q. Does that article not say that the De Forest equipment was withdrawn from the market about a year before?

Mr. Darby: If your Honor please, I object to that question.

The Witness: I don't care what the statement says. I know it was not.

Mr. Darby: Just a minute, please. I object to the question. That is merely another way of getting into the record something which is obviously irrelevant and immaterial and I object to the question.

Mr. Ashton: If your Honor please, Mr. Berliner examined Mr. Schlesinger and gave the impression that the predecessors of this company had been in this talking motion picture business successfully during this period from 1923 on. That is just the sort of thing that I want to show is not true.

The Court: Since when has any newspaper been regarded as an infallible source of news information?

Mr. Ashton: It is not, your Honor, except that is a statement purporting to

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have been made by Dr. De Forest himself, who was in intimate charge of this matter, and I want to know whether that does not refresh Mr. Schlesinger's recollection as to exactly what happened.

The Court: I think it is fair to ask if it refreshes his recollection; that is perfectly proper, but I do not think it is competent evidence.

Mr. Ashton: I am not offering it, your Honor.

1190

Mr. Darby: He has asked the witness that question, and he has answered it, and the ground of my objection is—

The Court: He said that his testimony is the same notwithstanding that statement in the paper. So we are all in agreement. A man's memory might be refreshed by almost anything you could think of, or it might not be.

Mr. Darby: But the last question to which I objected attempted to put in evidence, and into the record what the newspaper said.

1191

The Court: Yes, I will sustain that objection.

Mr. Ashton: I had no intention of putting it in as an exhibit; I simply showed it to him to refresh his recollection.

The Witness: The De Forest reproducing equipment was being offered during the year 1928 prior to my company coming into the field. I was one of the customers, as a matter of fact. There was no high class organization for sales, but it was there on demonstration in the 48th

1192

Max A. Schlesinger—For Defendant—Cross.

Street office, where I saw it for the first time. I have no recollection that it was withdrawn from the market before that time. That is news to me that it had ever been withdrawn. I was present during the trial of the case in Delaware, when Dr. De Forest testified, the case which the General Talking Pictures Company brought against Stanley Company of America on our patents. I have no recollection of the detailed testimony. If you will refresh my memory on what he testified to, I will answer whether I remember it or not. I was not familiar with De Forest's activities until about 1927. I did not know what an amplifier was then. I do not remember whether he had Western Electric amplifiers or what he had. I knew that there was talking picture apparatus both for recording and reproducing.

1193

Q. I did not get quite clearly, Mr. Schlesinger, your reference to your conversation with Mr. Otterson, about the time of Mr. Otterson's going abroad; do you know when Mr. Otterson went abroad in 1929? A. Now, you are getting on a hazy subject. I will have to think carefully of the dates here involved. When the German patent deals were up, is the time when Mr. Otterson—

1194

Q. Pardon me if I interrupt you. The question is do you recall when he went to Europe in 1929. Now, just think it out to yourself, and don't tell us the course of the operation. A. No, I do not recall the exact date.

By Mr. Ashton:

I did not testify that Mr. Loughead stated to me that a representative of the R. C. A. had in-

Max A. Schlesinger—For Defendant—Cross. 1195

spected the "Amer. Tran." Company's books prior to December. I testified that the licensors knew what they were doing by having the books open to them for inspection under the agreement. I did not say they actually inspected the books. The only time I met Mr. Langhead was in July, 1929, in my office.

The Court: Let us pause a moment, because I want to get that straight. The witness testified that his books disclosed sales of the American Transformer Company to the witness and Mr. Loughead had said that he had reported to the Western Electric officials these sales. 1196

Q. Is that what you meant to say, Mr. Schlesinger? A. Either a Western Electric official or representative, I am not sure,—a representative of the Western Electric Company. The question asked by you was the Radio Corporation, Mr. Ashton. I referred to the Western Electric Company. There are two separate references there. One in which I said the books were open, and one where I said Mr. Loughead reported to me that he had a talk with a Western Electric representative. 1197

By Mr. Ashton:

I had both in mind, but there are two separate references and I think they are so referred to in the letter. I did not testify that Mr. Loughead told me that the Radio Corporation of America representative had actually inspected the books at the time of my conversation with him in July.

1198 *Max A. Schlesinger—For Defendant—Cross.*

We made our first installation of General Talking Pictures theatre apparatus in Canton, Ohio, about October or November—October of 1928, the latter part of 1928. I would not like to bind myself to the exact day and month, but it was between the date of incorporation in September and the end of the year. Yes, between the date of the incorporation and the end of the year.

1199 We made an installation in the Strand Theatre at Allentown, Pennsylvania.

(Contract marked Plaintiffs' Exhibit 35 for identification.)

By Mr. Ashton:

1200

If that was the actual original contract which you show me, the likelihood is an installation resulted from that, although I could not testify from my own knowledge when the installation was made. I cannot tell from this about when it was made. Sometimes an installation would not be made as a result of a contract; it would be cancelled before the installation was made. There was great difficulty in getting engineers to do the installation on time. We never committed ourselves to any definite date. I do not remember that installation specifically, but what I do remember specifically is before the close of the year 1928, the one in Canton, Ohio, was in, the first installation.

I do not know whether he advised me about the American Transformer license not being cancelled, but he told me what I could buy under it. I looked at Mr. Darby's opinion some time ago,

Paul J. Larsen, For Defendant—Direct.

1201

—a long time ago. I read it this morning again, when you referred to it.

The purpose of the visit of the Radio Corporation engineers was that they wanted to take space for recording and demonstration purposes in our studio; because there were not many sound studios in New York or elsewhere at that time. It was early in my career in the talking motion picture business, very early; before I had decided whether I might go into the recording picture business as part of my enterprise, and I decided that I would not, so I did not mind having another company use it.

1202

Re-direct Examination by Mr. Berliner:

I knew that those tubes about which Mr. Ashton asked, were licensed and they had restriction notices on them. I knew it either by seeing the cartons or by the tubes, or what Mr. Darby told you. Those are the tubes used with the amplifier.

1203

PAUL J. LARSEN, called as a witness on behalf of the defendant, having been duly sworn, testified as follows:

Direct Examination by Mr. Berliner:

My residence is 18 East 198th Street, New York City. I am an electronics engineer. I am not a licensed engineer. In 1928 and 1929 I was employed by the RCA Photophone Company. That is a subsidiary of the Radio Corporation of America. I was the manager of production,

1204 Paul J. Larsen—For Defendant—Direct.

service and installation from June, 1928, until July, 1929, and manager of production from July, 1929, till October 15, 1929. I was associated also with Dr. Goldsmith of the Radio Corporation of America. He was located at the same place and was vice-president and chief engineer of the RCA Photophone. I had many contacts with him. I knew Mr. David Sarnoff, president of the Radio Corporation of America, and during my employment, occasionally saw him on the premises. I had no part in the preparation of the licenses of which Defendant's Exhibit E is a copy, between Radio Corporation and American Transformer Company, but knew of those licenses. I knew of the license to the American Transformer Company, Exhibit E. The same licenses were granted by the Radio Corporation and allied corporations to other licenses as well, there were quite a number.

Q. Just to refresh your recollection, I show you this paper.

1206 Mr. Neave: I do not see how this witness would know about the licenses,—if he states the fact, I don't know that he needs to explain it.

The Court: You can show that on cross examination.

The Witness: The Radio Receptor Company was one of the licensees.

In the course of my work during 1929, I knew that General Talking Pictures Corporation was using amplifiers manufactured by American Transformer Company. My first knowledge of that was some time in March, 1929, when Mr. Sawyer, one of the vice-presidents of the RCA

Paul J. Larson—For Defendant—Direct.

1207

Photophone and Mr.—I don't recall his name, he was a director of the RCA Photophone Company and Mr. Harold Bucher of the engineering department—of the RCA Photophone; Mr. Carl Dreher, also of the engineering department,—we all visited the General Talking Pictures studio on 48th Street.

By the Court:

This was some time in March, 1929, in the early part of March, for the purpose of taking space there for studio activities. At about the latter part of March or the first part of April we also—

1208

By Mr. Berliner:

While I was at the studio, I saw the equipment and apparatus of the General Talking Pictures Corporation, both recording and reproducing. I saw amplifiers connected therewith that were manufactured by and bore the name-plate of American Transformer Company. The next visit was the latter part of March, or the first part of April, 1929, when we visited, I believe—the name of the theatre is Grand, it is upstairs in the building of the Grand Opera House, I believe it is on 23rd Street, around Eighth or Ninth Avenue, somewhere around that district, we visited there for the purpose of seeing the possibility of utilizing space there for studio facilities. There was an installation of General Talking Picture equipment there. We did not examine the equipment carefully, but we saw it. I saw the American Transformer amplifier.

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When I went to the studio on my first trip in March, it was at the request of E. E. Bucher,

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Paul J. Larsen—For Defendant—Direct.

the executive vice-president of the RCA Photophone. No representative of General Talking Pictures Corporation was along with me. Dr. De Forest was there, and I believe there was some other gentleman upstairs in the rear part of the studio, but I don't recall his name.

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I knew that the amplifiers manufactured by American Transformer Corporation and sold to General Talking Pictures Corporation were used by the latter company and leased by it to theatres throughout the country. I discussed that fact with the other officials of my company. At different times, we discussed it—that discussion came up. The discussions that I remember along that line were held at our weekly official meetings between the officials of each of the respective departments. We at all times discussed the competition we had from other organizations out in the field, and our different service representatives throughout the field at all times reported back to us the type of equipment that was installed and the organization that had sold it, and we were acquainted with what equipment was being brought in by outsiders,—by bootleg equipment, as we called it.

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Q. Was there any objection raised by the RCA or their subsidiaries to the use of this American Transformer amplifier used by them? A. I have no knowledge of it.

Q. Do you know whether at the same time under the same license, other licensees like Radio Receptor were offering similar amplifiers for theatre purposes? A. I don't recall that.

Mr. Neave: I do not see the materiality of that, your Honor.

Paul J. Larsen—For Defendant—Direct.

1213

The Court: The witness said, "I don't recall that," so that relieves us of any discussion about it.

The Witness: I didn't say that.

The Court: Will you read his answer?
(Answer read.)

Q. Will you repeat your answer now? A. I do know.

Mr. Ashton: I object to this line of testimony, because I cannot see that it has any bearing on this case.

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The Court: This line of testimony?

Mr. Ashton: We have a specific question, what did he say about that? I say that is going to suggest that other companies were selling amplifiers for talking picture purposes; other companies who had licenses similar to this American Transformer license, and I say what those other companies were using can have no bearing on this case whatever.

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The Court: Objection overruled and exception.

Q. That amplifiers were sold by other licensees?

The Court: Don't put the answer in his mouth. Ask him what he knew.

Q. What did you know about the use of the amplifiers made by licensees under the same licenses other than the American Transformer Company?

1216

Paul J. Larsen—For Defendant—Cross.

The Court: You spoke of a certain one in your previous question.

Q. The Radio Receptor, do you know? A. I do know.

The Court: He may state what he knows as to what was done by Radio Receptor Company.

1217

I know some equipment that was installed, utilizing some of their amplifying equipment, and in October, 1929, I myself made contracts for my own company, not the R. C. A. Photophone, with the Radio Receptor Company for the use of their amplifiers for use in talking motion pictures.

I do not know whether the Radio Corporation of America approved the use of these amplifiers supplied by the American Transformer Company to the General Talking Pictures Corporation.

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Cross Examination by Mr. Neave:

I was considered an officer of the RCA Photophone; manager of production, service and installation. I was concerned with the demonstrating policies in production, service and installation of all equipment throughout the United States. I had nothing to do with the patent policies of the RCA or the RCA Photophone, and was not consulted in that connection.

EMANUEL M. ZELONY, called as a witness on behalf of the defendant, having been duly sworn, testified as follows:

Direct Examination by Mr. Berliner:

I reside at the Great Northern Hotel and am a factory representative. I was special representative for amplifiers with the American Transformer Company from 1928 on. I was not employed but was made special agent for a certain purpose. I know all the executives of the company, the president, Mr. Loughead and Mr. Schermerhorn, vice-president and general manager and the engineers. During the Summer of 1928 I went over to the American Transformer Company before I knew of the General Talking Pictures Corporation. My knowledge of the talking picture industry led me to believe that there would be quite a market for amplifiers in the field.

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Mr. Neave: I object, your Honor.

The Court: Yes, sustained.

Mr. Berliner: Exception.

The Witness: When I went to the American Transformer Company, I asked them whether they make any amplifiers for talking picture purposes. They told me that they were not familiar with the art, but they had made some amplifiers, but they did not know how they were using them. I suggested that they make an amplifier for talking pictures and I said that I could get them a lot of business. I spoke to Mr.

1222

Emanuel M. Zelony—For Defendant—Direct.

Schermerhorn. Mr. Loughead was not yet with the company. After, we had quite a conference about it; they did not realize the amount of business there would be—

The Court: Never mind that. Just answer the question.

1223

The Witness: We finally decided that I was to take charge of it entirely, that is, of the amplifiers to be used in connection with talking movies. I went out and solicited business for them, for that purpose. I went out calling on the trade, everybody, including General Talking Pictures. At that time I saw their purchasing agent, a man by the name of Mr. Zeiger and the chief engineer, Mr. Tappan. A little later on, during the Fall of 1928 I met Mr. Schlesinger. I went to see General Talking Pictures Corporation in the Fall of 1928. I tried to and did sell them amplifiers for use in talking pictures. I told them that they were licensed by the RCA,—that these manufacturers were licensed by the RCA

1224

and had the conventional limited license on it, that is all. Thereafter I made substantial sales of these amplifiers to General Talking Pictures Corporation. The sales continued until about July of 1929. What happened when we sold quite a few amplifiers to the General Talking Pictures Corporation was that Mr. Schlesinger called me in and asked me if I could effect some kind of a contract where I could furnish a certain amount of amplifiers delivered at a certain time, and so on, but I had no authority to make any such contract. He suggested he wanted to buy several thousand. I had to get in touch with the company and talk it

Emanuel M. Zelony—For Defendant—Direct.

1225

over with Mr. Loughead and Mr. Schermerhorn, which I did. The conference was at Mr. Schlesinger's office. We had our first conference at Newark, at which Mr. Schlesinger was not present. At the conference in New York Mr. Schlesinger said to Mr. Loughead that he had done a lot of business with us and he never had any official communication as to what rights or how much American Transformers can assure him by continuing the supply in the business. Mr. Loughead said, "So far as we are concerned, we are going to make amplifiers; they are all licensed and we are selling them. No one has called our attention to it." Then Mr. Schlesinger asked Mr. Loughead for a letter agreeing that they would supply a large order of amplifiers, if they would order them. Mr. Schlesinger wanted to know whether all the amplifiers he purchased had royalties paid on them. The reply was yes. As a result these exhibits, Defendant's Exhibits J and K were sent to General Talking Pictures Corporation; I remember those letters.

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Q. When you first approached General Talking Pictures Corporation and you told them that the apparatus of the American Transformer Company was licensed, was any point raised about the restricted license notices? A. I don't get that.

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The Court: He has already explained that there was a limited license; that was explained.

The Witness: Yes.

Q. Before the letters, Defendant's Exhibits J and K were sent, were there other conferences had in Newark between yourself and the Amer-

1228 *Emanuel M. Zelony—For Defendant—Direct.*

American Transformer Company with respect to the contents of that letter, so far as you know? A. As far as I know, we discussed it ourselves many times—that letter, at Newark.

Q. Before it was sent? A. Before it was sent, yes.

I understood from Mr. Schermerhorn that the subject matter of the letters, Exhibits J and K, were first taken up with counsel of American Transformer Company. Before they were sent out now, in the Spring of 1929, the amplifier manufactured by American Transformer Company was exhibited and displayed and operated at the Radio Show in Chicago. I was there; Mr. George Krum, our chief engineer, was there, and representatives of the RCA were there.

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The Court: We can assume that they were.

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The Witness: That amplifier was displayed at that convention in connection with its use for talking motion pictures, general use, everything, public address systems, radio, anything you wanted to use it for. I do not know of any protest ever made by the RCA against these sales by the company to General Talking Pictures Corporation, until December, 1930.

Q. Now, Mr. Zelony, during your work with the American Transformer Corporation, before July of 1929, that is from January to July, 1929, during that period, was any talk ever had with you, by you rather, with any representative of the Western Electric Company? A. Yes.

Q. Or the Electrical Research Products Company? A. Yes.

(Recess until 2 p. m.)

Emanuel M. Zelony—For Defendant—Direct. 1231

(AFTERNOON SESSION.)

EMANUEL M. ZELONY resumed the stand.

Direct Examination Continued by Mr. Berliner:

Before my conference with Mr. Loughead and Mr. Schlesinger in July of 1929 I had a conference in 1929 with Mr. John A. Otterson, a representative of the plaintiffs. It came about in this way: When the amplifier business got so big, we talked about it over at the factory, just whether we were pursuing the right course and what we were going to do about the sale of these amplifiers. I volunteered to those at our company—I said, "I will go over and see Mr. Otterson." I saw Mr. Otterson at 195 Broadway, after lunch. It was some time in June, 1929, I should say. I told him that I represented the American Transformer Company and we were getting a lot of orders for amplifiers, and that we just wondered—when I said we I referred as far as the American Transformer Company was concerned—whether we were all right in selling these amplifiers for the purpose of talking pictures. Later on as we continued the conversation, I mentioned General Talking Pictures Corporation in the conference. Then we discussed other things and we wound up by saying—well, he said so far as he is concerned there is no objection, and the only objection that he told me was that the other amplifier manufacturers on the market were selling cheap equipment, and that it spoiled some of their recordings, that the Western Electric had spent millions of dollars to improve, and that the cheaper

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1234 *Emanuel M. Zelony—For Defendant—Cross.*

product on the market really did not do them justice. There were lots of other things that were said. I told him I am selling amplifiers to General Talking Pictures as one of our customers, and that I have sold to others as well. He did not make a comment, except to indicate he understood so. He did not act surprised or anything and did not object.

By the Court:

1235 He said that as far as he was concerned there was no objection.

Cross Examination by Mr. Neave:

I testified this morning about the meeting between Mr. Loughead and Mr. Schlesinger at which I was present. During that meeting no draft of letter was prepared, to be written by the American Transformer Company to the General Talking Pictures Corporation, it was just a general discussion. I saw a draft of letter of that sort with Mr. Loughead, over at the factory in Newark. It was typewritten when I saw it. It was prepared over in Newark. I would not remember whether I ever saw this paper dated July 3, 1929, Plaintiffs' Exhibit 29 for Identification, which you show me now. During my interview with Mr. Schlesinger and Mr. Loughead there was no preparation of any paper of any kind, that I know of, nor during any subsequent meeting and at which those three were present. I do not recognize the handwriting in the upper lefthand corner of that exhibit which you have just shown me.

Mr. Berliner: That is the defendant's case, except for stipulations.

Mr. Darby: It is stipulated for the purposes of this case that prior to the filing of the bills of complaint herein all tubes bought by defendant and used with its apparatus here charged to infringe were tubes manufactured under license of the tube patents of plaintiffs and Radio Corporation of America, and that they all were sold with one or the other of the license notices restricting the use of the tubes, which have heretofore been spread upon the record.

It is likewise stipulated that on June 27, 1929, the defendant company, General Talking Pictures Corporation and the De- Forest Fonofilms, Inc., filed a bill of complaint against the Stanley Company of America in the United States District Court for the District of Delaware, charging infringement of four patents owned by the plaintiffs in that action, and the equipment charged to be an infringement in the action was Electrical Research Products equipment, talking motion picture equipment, and that Electrical Research Products openly undertook the defense of that case and controlled and directed the defense of that case.

The defendant rests.

PLAINTIFFS' REBUTTAL

Mr. Ashton: Am I correct, Mr. Darby, in understanding that you agree that the Dr. Arnold referred to by Mr. Kendall in

1240

Chase.

his testimony is the Dr. Arnold who was patentee of several of the patents in suit; and also that Dr. Arnold died last July?

Mr. Darby: That is correct.

Mr. Ashton: Do you agree that you will make no point of the matter that Mr. Kendall testified to—namely, that these suggestions and particularly as regards the subject matter of Arnold patent 1,448,550, were made to him by Dr. Arnold; also with respect to patent 1,520,994?

Mr. Darby: The request is pretty broad, Mr. Ashton. The witness has testified to that. Now you are asking me in advance of argument whether I am going to attack the testimony of the witness.

Mr. Ashton: I spoke to Mr. Darby about this just at the conclusion, and in an effort to avoid calling additional witnesses. I am not asking Mr. Darby or insisting that he stipulate it. It is a question whether we can eliminate these witnesses, and I understood you to say we would attempt to state it here.

Mr. Darby: What I mean is this: Mr. Ashton several times during the taking of testimony has made the statement that he has carried the date of the invention back. I criticized his statement at the time. The evidence is in. Whether it carries it back or not is something that is going to be determined later. Now, I do not want to admit that it does and do not want to say that it does not, at this stage of the case certainly.

1241

Frank N. Waterman—For Plaintiffs—Rebuttal
Direct.

1243

Mr. Ashton: Then, we will call the witnesses.

Mr. Dabbs: If you think it is sufficient, all right; but if not you better put on your additional proofs.

FRANK N. WATERMAN, recalled by the Plaintiffs, in rebuttal, testified as follows:

1244

Direct Examination by Mr. Ashton:

Q. Refer now to the prior art which has been discussed with respect to the Lowenstein patent in suit No. 1,231,764. The first is the De Forest patent 841,387. A. The De Forest patent shows a variety of ways of controlling the current in a tube. Fig. 2, which as I recall was chiefly discussed, shows a tube having a filament and two electrodes D and D¹, D¹ serving as an input electrode to receive the signal and taken from the antenna V from the air and detected by a detector T¹¹. The function of this detector is to separate the radio frequency from the received modulation that it carries, and permit the modulation to be heard in the output device R, or to be otherwise recognized by the actuation of that device.

1245

The figure shows a battery B¹¹ in the input circuit. It was customary with many of the detectors employed at that time to employ a sensitizing battery, sufficient current being sent through the detector to keep it in its most sen-

1246 *Frank N. Waterman—For Plaintiffs—Rebuttal—
Direct.*

sitive condition. The battery B^{11} is not described as to function, nor indicated as to polarity, but it is presumably the ordinary sensitizing battery for the detector T^{11} .

For this purpose it would be necessary that it should be poled with its positive pole to the element D in the tube, since only in that event could the sensitizing current flow through the detector T^{11} . The batteries shown in the patent are all indicated as to direction of connection by plus and minus signs, with the exception of this battery B^{11} and the battery B^{111} in Fig. 4. In the case of Battery B^{111} it is entirely immaterial which way the battery is poled.

I note that the use of symbols in the patent does not follow any consistent scheme. The battery symbol consisting of a long thin line and a short heavy line is used in one sense or the other indifferently. For instance, in Fig. 2 the heavy lines are plus; in Fig. 3 the heavy line is minus. Thus there is nothing to indicate polarity in the event that the batteries do not have the polarity indicated.

By the Court:

Q. In 1907 was there a convention in reference to the marking of the batteries? A. No, your Honor, way back in the times when I was in college I was taught that there was. The heavy line which was supposed to represent the consumable element was negative, but that convention fell into disuse and there has been no consistency in the use either in 1906 or since.

Frank N. Waterman—For Plaintiffs—Rebuttal— 1249
Direct.

By Mr. Ashton:

Q. Will you now refer to the De Forest patent 879,532. A. This patent shows for the first time in the art a grid audion; that is, the 3-electrode tube with the grid element for the control element. It was pointed out, as I understood, that the input circuit, namely the circuit connecting the grid to the filament, was returned to the negative side of the filament battery in both cases.

1250

By the Court:

Q. What do you mean by both cases; in Figs. 1 and 2? A. That in Figs. 1 and 2, yes.

Q. Which is the grid in Fig. 2; is it F? A. There is no grid in Fig. 2, but the control element is A¹.

Q. That takes the place of the grid? A. It takes the place of the grid, yes, your Honor.

The Witness: (Continuing.) The first electron tube to be used in connection with wireless telegraphy was the 2-electrode tube of Fleming. It had a hot filament and a plate, and was originally used without any local battery. The signal was put into the circuit connecting the plate element and the filament, and Fleming directed that that external circuit should go from the plate element to the negative side of the filament battery, and that became customary, and the illustration of this De Forest patent is in accordance with that conventional use. But the grid is not connected to the filament in either of these cases, because the circuit is broken by the con-

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1252 *Frank N. Waterman—For Plaintiffs—Rebuttal—
Direct.*

denser. Therefore, as a matter of fact, the grid gets no polarization or potential from the filament whatever, but is what is called a floating grid. If the condensers were not present, then the grid would have the normal potential of the negative end of the filament, and would be in accordance with conventional practice with respect to the 2-element tube. It would not, however, be ultra-negative.

1253

By Mr. Ashton:

Q. We will now take up the Stone patent 884,110. A. The Stone patent points out at page 1, line 60, that the patentees have found that the sensitiveness of the audion when connected in the absence of a polarizing means in the grid circuit was greatly impaired from causes which were obscure, and therefore not discussed, and it states that the probable cause is that the conducting member G becomes negatively charged. In the next paragraph it is stated that the sensitiveness of the audion may be greatly increased by inserting a battery shown at Z, polarized to make the grid positive with respect to the filament. The tubes of that day often exhibited the effects of gas in the globe, and the use of the positive battery is probably suggested by Stone and Cabot in connection with such tubes in a circuit calculated to operate on what is known as plate side detection, in which case the grid is given a bias by a battery and operates to produce the rectifying or detecting action necessary in wireless telegraphy.

1254

Q. The next patent is De Forest 995,126. A.

Frank N. Waterman—For Plaintiffs—Rebuttal— 1255
Direct.

It was pointed out, as I understood the testimony, in connection with this patent, that there are three illustrations of a 3-element tube. One at the right in Fig. 1, one at the left in Fig. 2, and one at the lower right in the same figure. It was stated that the grid of each of the three tubes was connected to the negative side of the battery heating the filament. This is true of the circuit, but it is not true of the grid. That is to say, in each case a condenser is included in the circuit so that the grid has no direct current connection to the filament whatever. That is to say, there is nothing to determine its potential with respect to the filament in either case. The system is a complex one, and I do not understand that it was described from any other point of view than that which I have just mentioned.

1256

Q. Take up the Von Lieben Patent, 1,038,910. I will ask you if you are familiar with the statement and the opinion of the Court of Appeals in the Wallerstein case which I read from the other day, and if they are correct statements so far as you know from the scientific point of view?

1257

A. I am familiar with them, and they are correct. The Von Lieben patent shows a tube of a very special character, which might be described as a Geisler tube built on top of an electron discharge device. That is to say, there are two chambers in this tube whose separateness, except as they are connected by the perforations in the partition H, is an essential matter. The space above the sieve member H and between it and the anode A acts like a Geisler tube, having the parallel electronic and the positive ion streams, and having the dark space character-

1258 *Frank N. Waterman—For Plaintiffs—Rebuttal—
Direct.*

istic of such a Geisler tube formed just above the sieve member H. The sieve member H is made positive with respect to the hot filament member and causes electrons to pass from the cathode to the sieve. These acquire a considerable speed and some of them heat the sieve and some of them go through the holes. Those that go through the holes set up by impact on the gas molecules in the upper portion a state of what is known as impact ionization which becomes self-perpetuating. The electrons act as bullets which strike the gas atoms and deflect therefrom other electrons, with the result that there are positive ions left. Those positive ions move in one direction in this upper space, while the electrons move in the opposite direction.

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Now this is the essential mode of operation. It is essential that the sieve should be positive in order to get the electron stream from the cathode up to this ionizing velocity. The signal imposed upon the sieve member acts to vary the limits of the dark spaces and in the operation of the tube one can see the dark space and see it fluctuating, fluttering just above the sieve.

1260

The action, therefore, is not in the least like that of the type of tubes known as audions with which we are concerned in this case, and the positive polarization of the sieve is essential, the device will not operate in any other condition. The positive potential is obtained by a potentiometer shown at the left hand c in Fig. 2, which is connected across the cathode, the movable point on the potentiometer being connected to the sieve. The adjustment as shown is about in the middle, which means that the sieve has ap-

Frank N. Waterman—For Plaintiffs—Rebuttal
Direct.

1261

proximately the potential of the middle point in the length of the cathode.

In Fig. 2-A there are two cathodes, the upper one K1 being the one primarily concerned in the operation of the tube. It is supplied by a battery B1, only a portion of that battery being employed to heat the cathode K1. The whole battery, however, is connected to the sieve so that in that event the sieve has a potential greater than any part of the cathode K1.

In Fig. 3 the cathode is of different construction, but the mode of polarizing the sieve member is the same as that in Fig. 2. In this instance the cathode takes the form of a sort of condensing mirror.

1262

By the Court:

Q. The battery is B in Fig. 3? A. No, your Honor, that is the microphone battery. The battery is Q, not shown. It is not shown whether it is a battery or what the source is, but there is a source there, the terminals of which are marked plus and minus, and the potentiometer c is connected across two lead wires going to heat the cathode. The movable arrowhead on that potentiometer resistance connects to the sieve member H, and again it is a positive potential that is applied, as is essential for operating purposes.

1263

By Mr. Ashton:

Q. Will you now refer to the Mathes patent in suit, the Grid Biasing Resistance Patent No. 1,426,754, and discuss first the Arnold Patent

1264 *Frank N. Waterman—For Plaintiffs—Rebuttal—*
Direct.

1,129,942, which was selected by Mr. Cloud as the best reference against this device. A. Fig. 5 of the Arnold Patent 1,129,942, shows an arrangement in which three audions are connected in tandem relation, the first two being high voltage amplifiers and the third being the power output or high current tube. These are resistance battery couples. The arrangement is what is known very often in the art as a direct current amplifier. It will respond to direct as well as to alternating current. The tubes are coupled; that is to say, the left hand tube and the middle tube are coupled together by virtue of resistance 14, and the grid of the middle tube is conductively connected to the top end of that resistance. That would mean that the grid took the potential of the top end of the resistance 14, in other words the same potential as the plate of the preceding tube, were it not for the presence of the battery 11.

1266 The filaments of these tubes are supplied by the battery 12 and are connected in series—that is, seriatim one after the other, starting from the positive pole of the battery 12 and following to the right a wire goes off to a resistance erroneously marked 14—the number 14 should apply to the resistance just to the left of it—then up through the filament 9, then to the left and through the filament 5 of the middle tube, again to the left through the filament 5 of the left hand tube, back to the battery 12, negative terminal.

Take for example the grid of the middle tube. The voltage which it would get would be the voltage of the battery 13 minus whatever loss

Frank N. Waterman—For Plaintiffs—Rebuttal— 1267
Direct.

of voltage occurred in sending the plate current of the left hand tube through the resistance 14, and minus the loss of voltage through the filament 5 of the left hand tube. This would be a very high voltage and would cause the middle tube to operate in an exceedingly defective manner if it operated at all.

There is, therefore used what is commonly known as a bucking out battery 11, which battery opposes the voltage on the plate 4 of the left hand tube, cancels it out, and has enough voltage left over, so to speak, to make the grid 3 of the middle tube about 5 volts negative with respect to its filament. 1268

In other words, without the battery 11 of the grids of the middle and right hand tubes would be highly positive. It does not appear what exists to the left of the left hand tube, but a battery 11 is shown for establishing a negative bias on the grid of that tube also. The negative bias, therefore, is obtained in the case of each tube by the use of a battery 11. In the case of Fig. 7 the input circuits of the three right hand tubes, each of which is marked 2, is derived from the battery 11 which in exactly similar manner to Fig. 5 bucks out or overcomes the voltage of the plate battery 13. But since the filaments are in series the two right hand batteries 11 are positively poled with respect to their grid elements in order to preserve on them the same negative bias as exists on the middle tube. In other words, in the outcome all three of the grids of the tubes 2 of Fig. 7 receive their negative bias directly from the battery 11. 1269

Q. Now the other Arnold Patent 1,129,943.

1270 Frank N. Waterman—For Plaintiffs—Rebuttal
Direct.

A. This arrangement is essentially the same in Fig. 2 of patent 1,129,943, as in Fig. 7 of patent 1,129,942, so far as concerns the grid circuits. The grid of the tube 4 is biased by the battery 6, which overcomes the voltage of the battery 9, the relation being that I have described with reference to Fig. 5 of the other patent 1,129,942. The grids of the three tubes 5 obtain their bias from the battery 6 located just at the left of the middle tube, and the batteries 12 are to preserve the grids of the two right-hand tubes at the voltage determined by the battery 6 last named, in spite of the voltage drops in their filament.

1271

Q. Will you now take up the Reisz Patent, tab 16, No. 1,234,489. A. The Reisz patent shows one of the Von Lieben type of tubes and the sieve H derives its bias from potentiometer W¹, connected across the filament terminals, and therefore the sieve voltage corresponds to that of some point of the filament and is sufficiently positive to a sufficient part of the filament so as to cause the requisite electron velocity to cause the dark space created in the upper half of the tube to be suitably located with respect to the sieve element.

1272

The Court: Will you please read that?

(Answer read.)

The Witness: Is not that clear to your Honor?

The Court: I cannot say it is clear, but that is not your fault.

The Witness: I will be glad to explain it.

The Court: This (indicating) is the filament!

Frank N. Waterman—For Plaintiffs—Rebuttal— 1273
Direct.

The Witness: The filament is K.

The Court: Where does the filament receive its current, from B¹?

The Witness: From the battery B. The plus terminal is marked by the right-hand terminal of battery B¹.

The Court: Oh, yes, I see, right above.

The Witness: Plus. Those circles indicate binding posts. The current flows up, through to the right-hand end of the filament K, then through the filament and from its left-hand end down to the switch S. Assume that the switch S to be closed, the flow takes place. Of course, if the circuit is broken at that part, no flow takes place and current then returns from the switch through the minus terminal to the minus end of the battery, thereby heating the filament. The potentiometer W¹ is connected across the leads or lead wires from the filament K, so that even if the filament K were broken, for example, the current would continue to flow through the potentiometer. In other words, in both the Von Lieben patent and the Reisz patent, the potentiometer is not a conductor carrying the same current which heats the filament as in the Mathes patent, but it carries a wholly independent current, but since it extends from one terminal to the other, a drop of potential will occur through it, which represents the same drop of potential as the drop of potential in the cathode or filament, although it is not produced by the same current. Then by tapping that potentiometer resistance W¹ at a suitable point, a definite amount of the total potential of the filament, as measured from

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1276 *Frank N. Waterman—For Plaintiffs—Rebuttal—
Direct.*

its left-hand or negative terminal can be taken up to the sieve member.

With respect to all the rest of the filament, which is the left-hand portion of the filament, the screen is positive and it operates in virtue of that fact, because electrons will only be attracted to positive circuits. They are therefore speeded up and given the necessary velocity so that such of them as happen to hit holes instead of solid portions carry through with sufficient projectile action to disrupt the atoms on the upper side, and when that occurs with sufficient violence, the ejected electrons, that is the electrons ejected from the atoms, will themselves collide with other atoms, and a state of self-perpetuating ionization is created, so that there is, to a large extent, a separation of the atoms in the upper chamber R in this Reisz patent into positive and negative ions.

The negative ions, being the electrons, and the positive ions being what is left of the atom.

1278 Q. Mr. Waterman, will you take the Colpitts Patent No. 1,388,450, tab No. 27? A. The Colpitts Patent 1,388,450, shows a radio transmitter and the portion of the apparatus that was referred to as I recall, was the right-hand portion of Fig. 2; two tubes 27 and 28 are in this instance, operated in parallel. Their filaments are heated in parallel by a generator 61 of alternating current. Across the terminals of this generator, is an inductance 62, this being alternating current, the inductance offers a high impedance. It is serving as a potentiometer across the terminals of the generator, and from the middle point of this potentiometer or thereabouts,

Burton W. Kendall—For Plaintiffs—Rebuttal— 1279
Direct.

a point, in other words, which is supposed, as I understand, to have the mean potential of the filaments of the tubes, there is connected to resistance 64, to the lower end of which is connected the negative pole of the plate voltage generator 66, shown at the right of the resistance 64.

This resistance 64, together with the two halves of the inductance 62, is therefore in series in the plate circuit of the tubes.

The grids of these two tubes are connected through the input circuit to the lower end of the resistance 64 and therefore to the negative terminal of generator 66. The effect, therefore, is to cause the grids of tubes 27 and 28 to be negative by whatever flow of potential is exerted in the resistance 64, and the two halves of the inductance 62 in parallel by the flow of the plate current. This is none of it filament heating current, but is the space current of the tubes that is flowing through the resistance 64 and which causes the bias, and the difficulty with that arrangement, as shown is that it tends to compensate out the signal. It has a de-amplifying effect produced in the input of the tubes which makes it highly objectionable in an amplifier.

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BURTON W. KENDALL, recalled as a witness on half of the plaintiffs, in rebuttal, having been previously sworn, testified further as follows:

Direct Examination by Mr. Ashton:

Q. Mr. Kendall, in your testimony the other day, you stated that Dr. Arnold had suggested to you—Dr. Arnold made the suggestion of the

1282 Burton W. Kendall—For Plaintiffs—Rebuttal—
Direct.

use of this potentiometer gain control across the input circuit of the repeater, which I had at Philadelphia in March, 1914, certainly later than the 17th of February and certainly as early as or earlier than the 7th of March, 1914. I have in my record book No. 25, p. 87, a record of some experiments we made on it about the 17th of February, and that is correct. Just before this one was photostated, that is dated 2/17/14, and

1283 those were tests of audions regarding gains with different inputs. I remember that as soon as he told me of this, we made a few brief tests in the laboratory, and within a very few days I went out to install this, and repeated this experimental use in Pittsburgh. The date, of that, of course, is given in the previous testimony in connection with this photostat.

Mr. Darby: No cross examination.

1284 Mr. Ashton: I would like to offer the additional page 87 of the notebook referred to by the witness known as Notebook No. 25, and ask that a copy be substituted for the original.
(Marked Plaintiffs' Exhibit No. 37.)

William Wilson—For Plaintiffs—Rebuttal— 1285
Direct.

WILLIAM WILSON, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

I prepared the memorandum, Plaintiffs' Exhibit 17, about which Mr. Espenschied testified the other day. I prepared it in May, 1915. It was completed May 26, 1915, the date of the memorandum. I prepared some of the drawings and Mr. Crandall prepared some of the others. They were prepared from the actual—those that I prepared, were prepared from the actual apparatus.

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Drawing ES-160,355, dated May 24, 1915, was prepared on or about that date. It was completed on that date. The receivers were completed on or about this date. I do not know anything more exact than that, a little earlier. Some of them were completed before this drawing and some were completed a little after this. I had seen the receivers at the time this drawing was prepared. At the time I prepared this memorandum I was working in the research department of the Western Electric Co., as research engineer. I now live at Jefferson Road, Short Hills, New Jersey, and am employed by the Bell Telephone Laboratories. I am assistant director of research.

1287

I operated one of the receivers myself at San Diego, California. I received signals there. It was the end of September or the beginning of October, 1915, I forget the exact date.

**1288 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.**

Cross Examination by Mr. Darby:

As to what became of those receivers, all that I remember about the one I had is that it was shipped back to New York. I think I saw one of them around a little while after that, but since that I don't know what happened to it. I do not believe they were sold, but I cannot say certainly. They were built in the engineering department of the Western Electric Company. I think they were not sold to the Telephone Company, although I don't know.

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FRANK N. WATERMAN, resumed the stand.

Direct Examination by Mr. Ashton (Continued):

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Q. Now, will you take up the Arnold patent in suit, No. 1,329,283, the Power Circuit Patent. I would like to ask you if you recognize the tube which I hand you? A. I do.

Q. State what you know about it. A. That is a three-electrode audion. I believe it to be one that belonged to me, which I bought, oh, perhaps in 1913 or 1914. I presume it was in the Winter of 1913-14, from Dr. De Forest, and which I used until I burned out both the filaments. All of the audions, so far as I know, had two filaments.

Q. Why did they have two? A. The filaments were very short-lived and the presence of two filaments was intended to double the life of the tube. Sometimes it did and sometimes it did not.

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1291

Sometimes the tubes went bad when one filament burned out.

Q. Was this tube the same tube that was an exhibit in the Wallerstein case? A. Yes.

Q. You produced the tube from your home during the trial of that case? A. I did.

Q. Where had you had the tube during the period prior to that? A. Oh, it had been stored with a lot of old apparatus.

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Mr. Ashton: This tube was Plaintiffs' Exhibit No. 52 in the case of Western Electric Company, *et al.* v. Wallerstein.

Q. The tube has been in the possession of counsel since that time? A. Yes, so far as I know.

Q. Now, will you describe briefly the construction of the tube with respect to the two tubes, Exhibits 12 and 16, and just make a brief comparison. A. This tube is a typical sample of the audion, as I knew and used them for a good many years. It has a small bulb originally containing two tantalum filaments. They operated, as I recall, on about four volts and took something over half an ampere, if my recollection is correct. Adjacent to and parallel to the plane of the filaments is a grid member formed by bending a wire back and forth to form a grid, looking like a succession of hairpins and parallel to the grid and spaced from it a short distance, there is a small plate element. The last two named elements were provided with lead wires, leading up through the top of the bulb, and it was customary to find them, as one purchased

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1294 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

them, covered with so-called stockings, the wire of the grid being a green stocking and that of the plate a red stocking.

The bulb was equipped with a miniature screw socket for screwing into a socket connected with the A or filament battery. In use, the filament circuit was the input, and the plate and filament circuit the output. The bulb was supposed to be evacuated. They varied very greatly in their vacuum, and were exceedingly erratic in their performance. It was quite customary for them to seemingly go bad, and this was apparently associated with a cleaning up of the gas. The battery that one could use on the plate circuit without producing the blue glow gradually increased, and the bulb quite commonly ran down in their apparent sensitiveness as that took place.

The blue glow, I might say, was a state of self-perpetuating ionization. The tube became the field, with a blue halo, and when that happened, all functioning of the tube ceased. The current rose to a very great extent, so much so, that if one had a very delicate measuring instrument in the circuit, it was very dangerous to the instrument. The normal current was extremely small, but when the gas ionization occurred, the current was very enormously greater. Except that the structure has a filament, a grid and a plate, there is little resemblance between these tubes and Exhibits 16 and 12.

Exhibit 16 has a grid of finely spaced fine wire, that is wire finer than in the original audion and more closely spaced. The separation of the grid from the filament is of the same general order as in the audion. The plates are

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Frank N. Waterman—For Plaintiffs—Recalled 1297
Rebuttal—Direct.

more widely separated. The Exhibit 12, however, has the grid wires much more widely separated from one another than in the audion or in the Exhibit 16, the plates are much larger. In both of the tubes, Exhibits 12 and 16, the filament is larger than the filament in the old audion.

Q. Was the electron emission sufficient in the old audion? A. It was very apt not to be. That may have been one reason why the tubes performed so badly when the gas cleared up. In general, the old audion had, as one might say, the defects of both kinds of tubes typified by Exhibits 12 and 16 and the advantages of neither.

Q. As to the power output of the type M tube, Exhibit 12, as compared with the audion, what would you say? A. There isn't any comparison at all. The output of the audion was exceedingly trivial, while that of the type M tube, Exhibit 12, is enormously greater.

Q. Of an entirely different order, would you say? A. Oh, yes; entirely.

Q. Now, mention very briefly the Seibt Patent No. 1,012,456, cited against this Arnold patent in suit 1,329,283. A. The Seibt patent shows what is known as an arc transmitter in a very schematic way. Off to the right of each of the figures, there is supposed to be a source of direct current, of large volume, together with certain stabilizing devices necessary to stabilize the arc. The arc jumps across the gap D and in shunt to that gap, there is the circuit CBE. C being a condenser; B an inductance acting as an auto-transformer and E a microphone.

The characteristics of this circuit determine the oscillation which takes place in the current

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1300 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

in the arc. In other words, a suitably circumstanced arc with suitable inductances and resistances in its supply line can be fed into a state of oscillation so long as there is enough to keep it being regular; the circuit CB serves something like the pendulum of a clock to keep that arc in a state of oscillation. The extent of the oscillation will be determined by the resistances.

1301 The microphone E in the circuit covers the resistance, and when one speaks into the microphone, that resistance varies the amplitude of oscillation, the extent of the current variation, in other words is affected and since the radiating antenna A is connected to the top and bottom ends of the coil B and is therefore influenced by the voltages set up in this circuit in shunt to the arc, which voltages are very much higher than the direct current voltage across the arc when so affected and the antenna radiates energy, and the high frequency waves would carry modulations representing the vibration of the microphone in response to the voice..The patentee goes

1302 into the theory of the resistance relations in the circuit and deduces that the greatest efficiency as stated on page 2, lines 3 to 6—the greatest efficiency will result when the resistance of the microphone is equal to the resistance of all the rest of the system, which must include, as I understand it, the resistance of the local circuit outside of the microphone and the actual resistance to the so-called radiating resistance of the antenna.

What he really solves there, is not maximum efficiency, but maximum output.

The mathematical treatment, so far as he goes

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1303

is simple enough, but he does not seem to include all of the factors. However, as far as it goes, it shows that the maximum output is attained when the resistance in the microphone is equal to the resistance of the rest of the system. It is a case of an investigation to determine what the relations are in a circuit of this kind. There is a general law where we have a simple transfer of energy from a source to a circuit, that the maximum output will be realized when the resistance of the load external to the source circuit is equal to the resistance of the source itself. That, so far as I know, in electrical matters grew out of the necessity for arranging batteries in a telegraph circuit in such a way as to get the greatest output. I know when I was in college, the standard problem we had in electrical engineering in that line were battery connection problems.

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Q. This patent was then a specific application of this law that you have mentioned, the general law? A. Well, it is an invention to find out whether the law held in a special case of this sort. It never could be presumed the law was going to hold; you had to find out.

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Q. So the mathematics at the top of page 2 were directed to that? A. Yes, all the mathematical discussion of the patent is directed to that ascertainment.

Q. And the conclusion deducted from those mathematics were to the effect that you have stated? A. Yes, on the basis of the assumptions made. I do not think it is a very thorough investigation.

Q. We will pass over the Arnold Patent 1,129,

1306 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

943, which was filed on the same date as the original patent in suit, 1,329,283, this Arnold Patent 1,129,943, being the reference which was selected by Mr. Cloud as the best reference and also by the patentee of the patent in suit.

1307 Now, mention briefly the Colpitts Patent 1,129,959, tab 12. A. This patent goes, as I understand, to an amplifier arrangement designed particularly for ocean cable telegraphy. In ocean cable telegraphy, the rate at which signals can be transmitted through the cable is very low, so that treating those signals as alternating currents, they are of the order of one or two cycles per second, and it is therefore a matter of extraordinary difficulty to make anything in the way of a transformer that would function, since the output of the transformer depends upon the alternation of the current flowing in, the higher the rate of alternation, the smaller can be the transformer, generally speaking.

1308 By the Court:

Q. Is the rate of alternation the same as frequency? A. Yes, your Honor. What Colpitts proposes is to connect into the cable circuit shown at the left in Fig. 1, a device whose input circuit can be wound so as to match the cable effectively. This device has an exceedingly high internal resistance. It is a tube device by Dr. Arnold and shown in some of his patents, and what Colpitts proposes is to connect the output of that high resistance tube to the input of a bunch of audions arranged in parallel. The output circuit of the audions being connected to the

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1309

siphon recorder 5. The specification, page 1, line 19 states that the law of electric circuits which I have referred to—

Q. Which line was that, please? A. Line 19. The patentee states at the top of page 3 that by using a number of audions in parallel, the combined impedance of the output circuit may be made of the same order of magnitude as the receiver or siphon recorder. In other words, Colpitts had to resort to the expedient of using a large number of audions in the attempt to get a sufficient current through the receiver 5, in order to operate it.

By Mr. Ashton:

Q. Does the patent contain any disclosure of a high power tube, such as disclosed in the Arnold patent in suit? A. No, it does not. It operates tubes having high plate circuit impedance. Each must be connected in—no, I don't think you can even say that. It refers to tubes having small currents and in order to get enough current, he had to use a large number of tubes, each contributing its part to produce sufficient current.

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Q. Would the output of these tubes be of the same or different order than in the patent in suit? A. So far as I know, the Arnold patent in suit for the first time discloses a tube having a high output current. This was the first high output current tube of the art, so far as any disclosures in the patent is concerned. In fact, the patent essentially says that.

Q. Do you have with you a copy of the patent for the mercury arc device of Arnold, which is

**1312 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.**

the first tube shown in this circuit of Colpitts Patent 1,129,959! A. Patent No. 1,118,172, of Arnold shows the sort of tube that is used in the first stage of this cable amplifier of Colpitts. The tube in general, is a mercury arc in which the element 5 is the main anode and the mercury pool 6, the cathode.

The arc is started by tipping the tube so that mercury from the compartment 4 runs over and touches the mercury in compartment 6, and then straightening the tube, an arc is formed, which is at once set up or duplicated between the anode 5 and the cathode 6.

The tube has a small auxiliary anode 9 and 2, plates 7 and 8, which are arranged at right angles to the normal arc stream. When a signal comes in from the microphone 16, it is connected through transformer 15 with the coils 11, 12; the magnetism set up by those coils causes ions in the arc stream to be deflected there towards the plate 7 or plate 8 and therefore current is caused to flow in the output windings 29, 28, which are windings of the transformer, called a split transformer. The battery 27 connecting between the auxiliary anode 9 and the two plates 7, 8, the flow of current in the coils 28, 29, sets up currents in circuit 17, containing receiver 18.

Q. Is this type of tube in use today as an amplifier? A. No. As far as I know, it was never used regularly. Dr. Jewett in a paper delivered, I believe, before the American Institute of Electrical Engineers, described its experimental use in a transcontinental line under the care of experimental engineers, but as far as I know, it has never had regular commercial use.

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Q. What would happen if a tube broke, for example, in a telephone plant, would it spill mercury? A. It would spill mercury all over the neighborhood. It would not be at all a nice thing to have in a telephone plant where high insulation is of the essence.

Q. Will you point out to the Court which specification to refer to? A. I cannot locate it now.

Q. Will you refer to the patent in suit, 1,329,-
283, and state with respect to the invention of
that patent such differences as there may be in
your opinion, from the disclosure of Patent 1,-
129,959?

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The Witness: Let me have the question,
please.

(Question read.)

A. The disclosure of Patent 1,129,959, is that by the use of a large number of audions connected in parallel, a sufficient output current can be obtained to operate a low resistance—comparatively low resistance device. The Arnold patent in suit shown is very different and much more useful an organization, in which the circuit of the output device is matched by the construction of a single tube whose output circuit impedance is of the same order as that of the output device itself. When the audions like the samples which have been shown me—I don't know whether it has been offered or not—

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Mr. Ashton: I am going to offer it at
the conclusion of this deposition.

A. (Continuing.) Like the audion of my own,
there was no known relation that existed between

1318 *Frank N. Waterman—For Plaintiffs—Recalled—
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the construction of the elements of the tubes and the performance of the tube. So far as I know, it was Arnold who unravelled that mystery and found out how the performance of the tube could be made to depend upon the construction of its elements.

By the Court:

1319 Q. Is that what is called the geometry of the tube? A. Yes, your Honor, that is known as the geometry of the tube, the relation between the geometrical elements of the tube and the performance of the tube, was a complete mystery. Arnold found that it was possible to make tubes have almost any characteristics that were needed, and so far as I know, Arnold was the first to recognize the fact that in convection current tubes of this sort, there was an alternating current resistance which was quite different from the apparent resistance of the tube which could be matched with the load.

1320 By the Court:

Q. By the load, you mean the output? A. Yes, the impedance of the output circuit. As I understand it, the invention described in the claims in issue is the production of a combination in which you have resistance of output devices equal to internal resistance of the tube by proportioning the construction of the tube.

By Mr. Ashton:

Q. DC? A. AC.

Q. I mean AC, excuse me. A. Colpitts did it by putting in tubes in parallel; Arnold did it by

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Rebuttal—Direct.

making a tube whose current fitted the device it was to be connected to, because the impedance was made low enough to match the impedance of the output device.

Q. If you are finished with this Colpitts patent, I believe you were, were you not? A. Yes.

Q. Will you mention briefly Langmuir Patent No. 1,558,426. If you recall, Mr. Darby read from this patent on his examination of Mr. Cloud. He read from page 3, lines 8 to 14. A. The statement on page 3, lines 8 to 14 is the geometrical proportion of the tubes affecting the amount of current to flow at a given voltage, but they remain fixed for any given device, and then he continues to a consideration of the law that the current will follow with respect to the voltage applied to the plates, letting a symbol represent that constant effect of the geometry. That passage does not say at all what the effect of the geometry is. If there are any other passages, I have not got them marked.

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Q. You will see one marked, page 3, line 93. A. Oh, yes, page 3, line 93:

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"The devices made to operate in accordance with my invention are capable of transmitting currents materially exceeding 1/10th of a milliamperes without causing positive ionization."

Of course 1/10th of a milliamperes is an exceedingly trivial current, of not so very different an order, somewhat larger, but not so very different order of those of the old audions, and in no sense a high current output tube, where the current is measured in many more amperes.

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Rebuttal—Direct.

Q. Does he describe the structure of the grid with wires very closely adjacent to each other, but without contact with the cathode? A. Yes, at the bottom of page 3, line 129.

Q. What would that be, a high voltage tube? A. That is a high voltage tube, but not a high current tube. There is nothing in the patent at all that I have been able to find, which indicates the possibility of construction of a high current output tube:

1325 Q. Is this patent concerned largely with the matter of vacuum in a tube? A. Yes, this is what I know as the high vacuum tube and it is concerned primarily with conditions affecting the vacuum and the application of the so-called three half power law, as the means of telling when the vacuum was high—the presence of gas interfering with the law.

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Mr. Ashton: I offer in evidence the old De Forest tube referred to by the witness as Plaintiffs' Exhibit No. 38.

(Marked Plaintiffs' Exhibit No. 38.)

Mr. Ashton: And the patent to Arnold No. 1,118,172, granted November 24, 1914, which is for the Arnold arc.

(Marked Plaintiffs' Exhibit No. 39.)

Q. We now take up the Arnold Patent 1,349,252, tab No. 4, Straight Line Characteristic Patent. Will you kindly explain briefly to the Court the curves which were previously put in evidence, to recall to his mind how that operates. A. It might assist in the understanding of the matter, if I were to point out briefly how these

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characteristic curves are taken, and I will refer, if I may, to Exhibit 5 in connection with Exhibit 24.

Exhibit 5 shows the simple audion diagram, and if we suppose, where the word "output" appears on the diagram, a measuring instrument adequate to measure the current flow in the plate circuit is placed, and where the word "input" appears we have some sort of a regulatable source of direct current voltage, by which we can, at will, make the grid there positive or negative by graduated means; that would be the set-up that is used in taking a characteristic curve, such as shown in Exhibit 24. You would ordinarily start by making the grid so negative, that no current reading was obtained in the instrument in the output circuit. A certain number of volts negative—we would draw, in preparation the horizontal and vertical co-ordinates, marking their junction zero, putting negative potentials at the scale on the left of zero and positive potentials of the grid at the right of zero, and then, if for example we made the grid 20 volts negative and found that there was no current flowing in the plate circuit; we would decrease the bias say, to 19 volts, and if we found a small current then at the scale reading for the 19 volts at the ordinate of the abscissa scale, we would indicate it by a dot, being the height or value of that curve by the height above the horizontal line, determined by a scale placed on the vertical co-ordinate or ordinate scale. So progressively we would decrease the voltage applied to the grid one volt at a time, and in each instance we would read the instru-

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1330 Frank N. Waterman—For Plaintiffs—Recalled
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ment in the output circuit and put a dot, taking the height of that dot on the scale on a vertical line. As we proceeded, we would find that the increase of current per volt change on the grid in magnitude and as we reach the zero point, the succession of dots would indicate a rather steep line.

1331 Then we would plot positive voltages to the grid and continue plotting those points indicating the value of the current reading in the output circuit. All this is on the assumption that some particular value of the B battery shown in Exhibit 5 was being used and maintained constant. As we continue, we would find that eventually the current in the plate circuit ceased to increase.

1332 We would then have obtained by connecting these dots with the smooth current, what is called a static characteristic of the tube for the particular value of the plate battery used. For further study of the performance of the tube, we could repeat the entire operation, using successively different values of the B battery, the plate battery, that is.

Referring to Exhibit 25, we have what is called a family of such curves—curve 1 being taken with a low plate battery, curve 2 with a larger one, and so on, curve 9 reaching the largest of the plate batteries.

Having thus charted the static characteristics of the tube, it would be possible to determine from them the so-called dynamic characteristic. The dynamic characteristic is a difficult concept to get, just as dynamic resistance or AC resistance of the tube in this patent No. 1,349,252,

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we have those two related to one another, that is, the characteristics as shown in this family of curves, Exhibit 25, are all curved. There is no part of any of the characteristics that is really straight. That means the introduction of harmonic frequencies not contained in the original signal.

The patent 1,349,252, points out that if the load impedance is contained in the plate circuit that is equal to or greater than the internal dynamic or AC impedance of the tube, the characteristic curves would then be different.

In response to alternating current, the rise and fall of the plate current would not follow these characteristic curves, but would follow a dynamic curve, which is determined by the AC drop in voltage in the plate circuit, as the grid potential changes.

If we imagine that where the word "input" appears on Exhibit 5, there is some source of alternating voltage which is rapidly varying the voltage of the grid with respect to the filament, we are thereby causing in the plate circuit rapid variation of current in the output circuit.

That current flows through the impedance of the load device connected where the word "output" appears in Exhibit 5. The passing of the alternating current through that load impedance consumes a certain portion of the voltage available from the battery, and a continually varying portion of that voltage. The result is that the voltage actually appearing, if we were to measure it between the plate and the filament, is a varying voltage, always less than the voltage of the B battery by the amount of voltage that is

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consumed in sending the current through the load.

Therefore we can from a family of curves such as shown in Exhibit 25 plot a curve or a series of points which we can join up to constitute a curve, by assuming a definite variation of grid voltage to determine each point. For accurate plotting we should have many more curves in the family than shown in Exhibit 25. This, however, will serve for purposes of illustration. In the explanation which I gave in my direct examination I assumed that the normal bias applied to the grid by a biasing battery or other suitable means was such that in the absence of any signal coming in, and with a B battery whose voltage was equal to that of the curve 7, we had a current equal to that indicated at the point where the lines A and B cross the line 7. Dropping down a perpendicular onto the horizontal scale gives the grid voltage that I assumed.

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JOHN E. OTTERSON, called as a witness on behalf of the Plaintiffs in rebuttal, being duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is John Edward Otterson. I am president of Electrical Research Products, Inc. I have been president of Electrical Research Products five or six years. I was formerly employed by the Western Electric Company. I was

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**John E. Otterson—For Plaintiffs—Rebuttal
Direct.**

1339

employed by the Western Electric Company in 1927 as commercial manager.

I have familiarized myself with the part of Mr. Schlesinger's testimony given here yesterday which relates to meetings with me. I do not agree with all of his statements. Referring to 1927, Mr. Schlesinger stated at page 387 of the record:

"We had several negotiations proposed, one in connection with talking motion picture equipment for foreign countries and others for talking motion pictures for South Africa generally, besides foreign; thirdly, a proposal to merge the patent situation that they contended they might have, as against those that I contended I had in the motion picture field."

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And over on page 388:

"We talked about the motion picture business in America and the probability and desirability of having motion picture producers of silent pictures undertake to go into the new field. We talked about my entering into the field, and after I had entered into the field, I again talked to them and told them how I progressed in it." We had general conversations relating to those matters.

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He continues: "I told them the equipment I was developing and my proposal to lease them, buy the goods in the open market and assemble them and then lease them to the theatres, and they asked me, 'What are you going to do about an amplifier?' I said, 'I would like to buy them from you.'" I had no such conversation.

The Court: Is this all with reference to 1927?

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Mr. Ashton: That is what I understood,
your Honor. It is not always clear.

The Witness: He also said, "They"—referring to me and Mr. Drake—"said that was rather a question; that they were using theirs for their own purposes; that the theatres were making a great demand for equipment; that they could not get the equipment fast enough for the growing industry, and I told them I had in 1928, around the campaign, obtained one of their licensed amplifiers, and I could get a supply of them." I do not remember that.

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Now on page 389 Mr. Schlesinger referred to a supply of amplifiers which he said he was obtaining, and said that he told me this: "I told him I was getting it from the American Transformer Company. I told Mr. Otterson that I was getting it from the American Transformer Company. He said to me, 'We are more concerned with the true reproduction obtained, so that the art is not impeded by the poor reproduction you get from bad sound.'" I made a statement to the effect that we were interested in seeing that the motion picture industry had good quality of sound; that that was our purpose. We were interested in that from the time that the Western Electric Company entered the sound field. It has always been our policy to direct our efforts toward the production of high quality of sound.

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Beginning at the bottom of page 390, which is supposed to be with reference to the Fall of 1928, Mr. Schlesinger stated: "At that time I merely told Mr. Otterson that I was able to procure an American Transformer amplifier for

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Direct.*

the campaign, and was discussing with him the possibilities of the Western Electric selling me more amplifiers. * * * He said that he had known of the good work of the American Transformer amplifiers; he thought the amplifiers, as reported to him, were good amplifiers; that it was a licensed amplifier, from one of their licensees." I did not say that to him.

He continues in response to this question, "Did he object to your purchasing and using it?" Mr. Schlesinger answered: "He did not." To the best of my recollection Mr. Schlesinger never informed me that he was buying amplifiers from the American Transformer Company, and we had no conversation at any time about the American Transformer Company.

The Court: Mr. Ashton, if I am not mistaken, the witness Schlesinger said that in those conversations he discussed the South African theatres and the possible exchange of licenses, and explained what he was doing with his patents in America. Will you ask this witness if those subjects were discussed, if he recalls?

The Witness: Mr. Schlesinger brought up the question of South Africa. I took no position in regard to it.

Q. Did you ever consider acquiring any patents which were controlled by Mr. Schlesinger?

The Court: I will ask you to reframe that: Was that subject discussed between them?

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Direct.

Q. Was the subject of the acquisition of patients discussed with Mr. Schlesinger?

The Court: The exchange of licenses.

A. Mr. Schlesinger proposed it. We never agreed to it and had no disposition to agree to it.

The Court: But it was discussed?

The Witness: Yes.

1349

We had considered the De Forest and Ries patents prior to the formation of Electrical Research Products, the Patent Department.

Q. What had been their conclusion?

Mr. Darby: I object to that.

The Court: May I interrupt? I am not much interested in that now. I am interested in the subject of conversations. .

Mr. Ashton: You asked about the negotiations, and I did not realize.

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The Court: What the witness thought and what they discussed are two different things.

By the Court:

Q. At any of those interviews did Mr. Schlesinger tell you what he was doing in the development of the patents that he said that he controlled in America? A. He told me that he was acquiring certain patent rights. He did not inform me in detail as to what they were. He stated that he was acquiring a very strong pat-

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Direct.

ent position that he believed was the basic control of the art.

Q. Do you agree that the conversations in which these latter matters were discussed took place in the Fall of 1928? A. About that time. I cannot place it exactly. It was during that period.

Q. So that the only respect in which your memory differs from that recited by the witness Schlesinger has to do with his reference to the American Transformer Company amplifiers? A. Well, as I read the testimony of yesterday it differed in other respects, your Honor. 1352

By Mr. Ashton:

At page 397 Mr. Schlesinger testified in response to this question: "What did Mr. Otterson tell you about whether he had or had not any objection to your purchase and use of the 'Amer Tran' amplifier?" The answer was: "That he had spent endless time and money"—referring to me, of course—"in trying to educate the manufacturers of motion pictures in the silent field to enter upon the recording business in talking pictures, and that he was particularly interested that people would use the amplifiers that would reproduce properly and accurately, and the American Transformer Company, he told me, was one of those who made a high-class amplifier.

"Q. Did he object to your using it? A. He did not object to it. On the contrary, he encouraged us to use it."

We had no conversation about the American Transformer amplifier.

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Direct.

The Court: Your answer still refers to the Fall of 1928, does it, or to a later time?

Mr. Ashton: I should point out, your Honor, that this statement which I read was supposed to relate to February of 1929.

The Witness: The answer is the same.

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By the Court:

That is, that in February of 1929 there was no discussion between me and Mr. Schlesinger concerning his use of the American Transformer amplifiers.

By Mr. Ashton:

And he says that I stated to him before July, 1929, and apparently he meant after February: "You go along, and competition is healthy, and as long as you make a good equipment I have no objection to it. . . . As long as you turn out a good equipment."—which meant the taking of a good amplifier and the rest of our equipment." I did not make that statement to him.

And he further said that I said, "as long as the royalty is paid it is quite all right." I made no such statement.

I recall no one by the name of Emanuel M. Zelony.

Mr. Zelony testified yesterday that I had a conversation with him some time in June, 1929, Mr. Zelony having stated that he was a sales

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representative of the American Transformer Company. And he testified as follows:

"I told him that I represented the American Transformer Company and we were getting a lot of orders for amplifiers, and that we just wondered—when I said we, I referred as far as the American Transformer Company was concerned—whether we were all right in selling these amplifiers for the purpose of talking pictures. * * * Later on as we continued the conversation. Then we discussed other things and we wound up by saying—well, he said so far as he is concerned there is no objection, and the only objection that he told me that the other amplifier manufacturers on the market were selling cheap equipment, and that it spoiled some of their recordings, that the Western Electric had spent millions of dollars to improve, and that the cheaper product on the market really did not do them justice. There is lots of other things that were said."

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And then he says: "I told him I am selling amplifiers to General Talking Pictures as one of our customers, and I have sold others as well.

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"Q. What did he say? A. He did not make a comment, except to indicate he understood so. He did not act surprised or anything. * * * He said that as far as he was concerned there was no objection."

I did not ever tell anybody that I had no objection. I have no recollection of anyone by the name of Zeleny, and I had no conversation of this character with anyone connected with the American Transformer Company at any time. I would not have been in a position to approve

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the manufacture and sale of talking motion picture amplifiers manufactured by other people at that time.

Mr. Berliner: I object to that, your Honor, as to whether he is in a position to approve.

Q. Why were you not?

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The Court: What have you to say to the objection?

Mr. Ashton: The point is that the Electrical Research Products and the Western Electric Company did not have at that time any rights which they could have extended of this nature.

Mr. Berliner: This agreement speaks for itself.

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The Conrt: The question is whether he would have been in a position to approve. At that time I think the witness said he was in charge of the commercial relations of the Western Electric. Is that it?

Mr. Ashton: He was at the time of these conversations first in charge of the commercial products, and then when Electrical Research Products was formed he was president of that company.

The Court: I think we should distinguish between the time he was president of Electrical Research Products and the prior time. As to the prior time, would he be the proper witness to state what the scope of his authority was?

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Direct.*

1363

Mr. Ashton: Yes, he would, your Honor, because he was immediately concerned with the very products which we are dealing here with, and in charge of the development of that commercial business.

The Court: Objection overruled, with exception.

Mr. Berliner: Exception.

Q. Prior to the formation of Electrical Research Products, and while you were with the Western Electric Company could—

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The Court: I think that you better ask him what his authority was, but do not ask him to construe it.

By Mr. Ashton:

As to what was my authority with the Western Electric Company prior to the formation of Electrical Research Products, I was charged with the commercial development of the inventions of the Bell Telephone Laboratories, outside the telephone field and including the talking picture field. I had the same responsibilities as related to the talking picture field that I did subsequently as president of Electrical Research Products. Previous to the formation of Electrical Research Products the development of the talking picture field was handled as a departmental development of the Western Electric Company. Subsequently the duties and responsibilities that I had as head of that department were conveyed to the Electrical Research Products and I became its president.

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Direct.**

At that time, when I was with the Western Electric Company, in charge of these commercial matters, the Western Electric Company did not have any rights from the American Telephone Company, which would have permitted it to extend licenses to manufacturers of talking motion picture apparatus.

Mr. Berliner: I object to that question, if your Honor please. He certainly is not competent to state that.

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The Court: I think he is competent to state whether there was an arrangement by which the American Tel. & Tel. had the right to grant licenses. I think he is probably the one who was most familiar with the policy of the Western Electric Company in regard to that.

Mr. Darby: May I be heard, your Honor?

The Court: Surely.

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Mr. Darby: The right of any of these parties to grant licenses is by this pooling arrangement; that is the best evidence of it. All that we can get by that question is the opinion of this witness, which I submit is incompetent. The contract speaks for itself in that regard.

The Court: The method of administering that agreement may throw some light on it. I am not sure that it is binding on anybody, but I think the evidence is competent. Objection overruled and you may have an exception.

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Cross.*

1369

By Mr. Ashton:

During the times in 1928 and 1929 when Mr. Schlesinger testified that he had conversations with me, Electrical Research Products did not have any rights under the patents of the Telephone Company which it could have extended to either the defendant or any other one manufacturing amplifiers.

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Mr. Berliner: We have the same objection, the same ruling and exception, your Honor?

The Court: Yes, the same ruling and exception.

Cross Examination by Mr. Darby:

I was made vice-president of Electrical Research Products about April 18, 1927; I don't recall the exact date. I was vested with all the authorities of a vice-president of the company at that time. It is my recollection that on December 19, 1927, I was elected president of Electrical Research Products, to be effective January 1, 1928, and from that time on I was vested with all the authority with which the president of a corporation is vested.

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I testified by affidavit in a proceeding in the United States District Court in Delaware entitled—or at least a series of proceedings—entitled, "Stanley Company of America, Inc., plaintiff, against American Telephone and Telegraph Company, Western Electric Company, Inc., and Electrical Research Products, Inc., de-

1372 John E. Otterson—For Plaintiffs—Rebuttal—
Cross.

fendants," and Duovac Vacuum Tubes, Inc., against the same defendants, and the defendant in this suit, General Talking Pictures Corporation against the same defendants. All the statements I made in that affidavit were true.

Q. As I understand your testimony, you deny that you ever discussed with Mr. Schlesinger at any time the fact that the General Talking Pictures Corporation was using American Transformer amplifiers, is that right? A. That is my recollection.

Q. You are quite positive on that? A. That is my recollection.

I cannot recall when I first knew that the General Talking Pictures Corporation were using American Transformer Company's amplifiers. It was later than 1928. I cannot say how much later it was; 1929, 1930 or 1931. Possibly it might even have been as late as 1931.

In my affidavit given in the Delaware litigation, verified October 21, 1932, I made the following statement:

"The Radio Corporation of America, an affiliate of the General Electric Company, which has operated in the field of sound recording and reproduction for motion picture purposes, was an actual competitor of the defendant Western and Vitaphone with respect to certain activities carried on by them and a potential competitor with respect to others, and since 1928 has been an actual competitor of the defendant Products in all of its activities in the motion picture field. These

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Cross.* 1375

facts are well known to plaintiff in this action. Prior to the execution of the original license agreement between the defendant Western and Vitaphone, Warner Brothers desired that the licenses granted to Vitaphone should be exclusive licenses. In connection with their expressions to this effect, Warner Brothers were fully and carefully advised respecting the subject matter of the reciprocal license agreements and, in particular, that the rights of the defendant Western covering the recording and reproduction of sound for motion picture purposes were non-exclusive. The activities of the Radio Corporation and affiliated companies in the motion picture field have covered the production, distribution and exhibition of motion pictures with related sound, the manufacture and installation of sound recording and reproducing apparatus and the granting of licenses for the use of this apparatus by others. These activities have been the subject of common knowledge in the motion picture and connected industries.

"Reference to the reciprocal license agreements is also made in the Warner Affidavit (Par. 4, pp. 7 and 8), and it is said with reference to the above mentioned contract of July 1, 1926, 'by said modification agreement the parties also pooled their patents covering the inventions relating to methods, systems and apparatus for the production and reproduction of talking motion pictures.' By this

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Cross.

comment, the affiant seems, as his language is read with the context, to insinuate that by the agreement referred to, the Telephone group of companies acquired exclusive rights 'relating to methods, systems and apparatus for the production and reproduction of talking motion pictures.' If such is the insinuation, it is wholly without basis in fact."

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Mr. Ashton: Just a moment, may I ask what is the point of this statement?

Mr. Darby: It has a vast number of points in this case and I am prepared to argue them out if it is necessary.

The Court: I think it is proper cross examination to call the witness' attention to the affidavit. I do not see the connection yet, but I suppose that is my fault.

Mr. Darby: Your Honor will soon see the connection, I am sure.

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The Witness: I made that statement and the statements therein made were true, to the best of my knowledge and belief at the time they were made; and they are still true today, to the best of my knowledge and belief.

Vitaphone Corporation is a subsidiary of Warner Brothers.

On page 67 of the same affidavit, I made the following statement:

"By the early autumn of 1928, I believe that the Radio Corporation of America, or one of its subsidiaries, had produced and made available to exhibitors repro-

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Cross.*

1381

ducing equipments in limited numbers. By the latter part of the year, as had been anticipated in May; a number of other equipments were advertised and offered. Many of these equipments were utterly unfit for the showing of pictures with sound and most, if not all, were of decidedly inferior quality. During this period, I myself and other representatives and officers of the defendant Products, did urge our producer licensees, for the protection of themselves and in justice to the other licensees and to defendant Products, to refrain from releasing product to theatres equipped with apparatus incapable of rendering reasonably satisfactory reproduction."

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The product referred to were motion picture films with sound.

And continuing the statement:

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"The producers had issued instructions to their salesmen not to arrange for the release of productions to theatres not equipped with apparatus furnished by the defendant Products unless the sound reproduction in such theatres was of good quality. Later, the producers became reluctant to rely upon the salesmen's judgment as to quality. They desired to arrive at some practicable and more dependable method by which they could, on the one hand, obtain as wide a market as possible for the productions, and, on the other

1384 *John E. Otterson—For Plaintiffs—Rebuttal—Cross.*

hand, avoid the risks which might be associated with releases to theatres not equipped for satisfactory sound reproduction."

That statement in its entirety, as you read it to me was true at the time I made the affidavit. And it is true to the best of my knowledge and belief at the present time. At the present time, the situation, of course, is different. The producers are not confronted with the problem to the same degree that they were then. The situation is different, but the statement is just as true as of that time, as it was when I made it, when I signed this affidavit.

Now, at that time, when talkies first became popular, I think it was true that the demand for reproducing equipment far exceeded our ability to supply it.

The statement in my affidavit continues:

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"The subject was discussed between representatives of the licensees and defendant Products; the objective of this discussion was not the obtaining of defendant Products' consent to indiscriminate distribution of pictures with sound, but to arrive at a plan which would be fair to the licensees, to defendant Products and to exhibitors, and at the same time protect the enterprise against the consequences of poor reproduction. This discussion took place in December of 1928. I verily believe that at no time, either before or after this date, was there any ex-

*John E. Otterson—For Plaintiffs—Rebuttal—
Cross.*

1387

hibitor in whose theatre was installed reproducing equipment capable of rendering reasonably satisfactory performance, who was prevented from obtaining or had serious difficulty in obtaining, product of any of the licensees of the defendant Products."

That statement was correct. And there again the term "product" was used to designate motion picture film with sound; some was on film and some was on discs.

On page 112 of the affidavit, I made this statement:

"The anticipation of defendant Products that inferior parts and devices would be manufactured and offered to exhibitors at prices less than those of defendant Products, has been fully realized. A great mass of so-called competitive product has been offered upon the market, most of which is inferior to that furnished by the defendant Products and much of which is utterly unsuited to installation in the reproducing equipments. Defendant Products, therefore, has continued the provisions originally incorporated in the leases of reproducing equipments by which the exhibitor is obligated to refrain from using, without the consent of defendant Products, parts and devices not furnished by Products.

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"With the course of time, devices have been manufactured and placed on the mar-

1390 *John E. Otterson—For Plaintiffs—Rebuttal—
Cross.*

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ket by others than defendant Products which are suitable for use in the reproducing equipments. Some such parts are available to exhibitors at the present time. Products has expressly advised exhibitors that many of these parts are suitable for use in the reproducing equipment and affirmatively communicated its consent to the purchase of the same in the open market by exhibitors. Other parts in many instances have been purchased and used by exhibitors without express consent of defendant Products. This has been especially true with respect to the practice of Warner Brothers and the plaintiff. In none of these instances has Products attempted to enforce, through legal proceedings or threat thereof, any technical rights which the leases of reproducing equipments may be said to create.

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"It is the purpose, policy and practice of the defendant Products to insist only that there shall be used in the reproducing equipments devices and parts free of patent complications and so designed and so manufactured that by the employment thereof the quality of performance of the apparatus as a whole shall not be impaired. It is my firm belief that the course followed by Products, as above described, has contributed substantially to the quality of sound pictures as presented to the public, and to the acceptance of this form of entertainment by motion picture audiences."

*John E. Otterson—For Plaintiffs—Rebuttal—
Cross.* 1393

I made that statement. The patent applications referred to in the last paragraph that was read from my statement, refers to the possibility of our licensed exhibitors using some equipment which might involve infringement of patents held by others. It also related to their use of apparatus infringing our apparatus.

Q. That is what you intended to convey by that? I will call something to your attention that might change your mind as to that last contention. I will not stop now on that because I want to pursue this thought for the moment. Under your agreement with the producers, you reserve expressly the right to take back the sound recording equipment of yours which was leased to the producer, if the producer distributed his film to a theatre for exhibition on a machine which did not give a quality of reproduction, which you considered to be equal to the quality of reproduction obtained with your own reproducing apparatus, did you not?

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Mr. Ashton: I object to that. He has already referred to the affidavit, and I would like to call your Honor's attention at this time to the fact that this cross examination is directed just about as much to another litigation as this one, if not more so. This case which was pending in Delaware, in which these same parties are involved, was an anti-trust case, and this examination seems to be directed almost entirely to that litigation.

The Court: I thought I detected a minute ago a possible connection between

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Case.

the witness' deposition in this case and something that he said in that affidavit, but I am rather inclined to think that the interpretation of that affidavit is not pertinent. I think you may call the witness' attention to his statement in that affidavit and then if you care to contrast that statement with what he said here, I think you have a right to do that. I do think, however, that to go into a discourse as to the policy of his company in other matters may not be relevant, Mr. Darby.

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Mr. Darby: On this particular question that is before the Court, I asked the witness if they did not reserve the right, which they did, and I think the witness will admit that, that in case the producer—

The Court: I heard the question and I tried to follow it.

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Mr. Darby: Now, anticipating that the witness' answer is going to be in the affirmative, my next question is, did he ever exercise that right with respect to any producer who distributed films which were exhibited on sound reproduction equipment of the defendant, General Talking Pictures Corporation.

The Court: Suppose he answers that either way, what light will that throw on the specific object of the present inquiry which is whether he had certain conversations with Mr. Schlesinger or not?

Mr. Darby: There is a sharp issue of fact between the testimony of Mr. Schlesinger and Mr. Otterson.

The Court: It could not be much sharper.

Mr. Darby: It is categorical. Therefore it is necessary to resort to surrounding circumstances for what light it might throw on which is correct. One of the surrounding circumstances is this fact: This witness has said, and so has Mr. Schlesinger, that their primary purpose was quality and what-not. Therefore, if it is established, and I believe it is the fact, that no criticism has ever been directed to the quality of the American Transformer amplifier apparatus or General Talking Pictures apparatus, then I think your Honor will see the logical purport of the testimony. Now, as to this matter, a lot may be said on either side on the question of the weight to be given to the testimony, but I think it is certainly competent.

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Mr. Ashton: May I point out, your Honor, that Mr. Darby is really now talking about another defense called "The Producer's License Defense" that is not pleaded in the answer in this case at all. It was pleaded in the Wallerstein case and was disposed of in this Wallerstein opinion, which you have here.

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Mr. Darby: You have misunderstood me.

Mr. Ashton: And I cannot see that it can have any bearing here, no matter what they may have done in that instance. This involved recording licensees and I want your Honor to understand they were not to manufacture apparatus, but to record sound and distribute film.

1402 John E. Otterson—For Plaintiffs—Rebuttal—
Cross.

The Court: I am going to attribute to Mr. Darby a desire to assist the Court in reaching a conclusion, and I am going to say that this line of inquiry will not help. I will sustain the objection.

Mr. Darby: May I note an exception?

The Court: Surely.

Mr. Darby: I do not want to press the matter beyond that point, but may I make a statement as to what I wanted to prove?

The Court: Certainly.

Mr. Darby: I wanted to prove by this witness in cross examination, that Electrical Research Products has never questioned the quality of American Transformer apparatus used in connection with reproduction of talking motion pictures.

The Court: I am willing that you should ask him that.

By Mr. Darby:

1404

We have in our own internal discussions questioned the quality of the operation of the American Transformer amplifying apparatus used in connection with reproduction of talking motion pictures. Whether we have ever served any formal notice on anyone to that effect, I don't know. As far as my personal knowledge is concerned, I have no recollection of ever having done so. It may have been done on the part of our legal or patent department or someone else in the organization besides myself. Personally, I have no recollection. I do not know that it has ever been done.

John E. Otterson—For Plaintiffs—Rebuttal— 1405
Cross.

In my discussion with Mr. Schlesinger, I believe I stated that I did recall that Mr. Schlesinger told me that he was acquiring patent rights. I suppose they could be described as the DeForest patents. He told me at that time that they were the DeForest patent rights. They were DeForest patents for the purpose of recording the sound-on-film. I think Mr. Schlesinger told me both that he was acquiring those patents and that he had acquired those patents. My 1406 recollection is that he told me he was negotiating for them and subsequently that he had acquired them.

I was familiar with the subject matter of those patents at that time. I told Mr. Schlesinger at that time that we claimed a license under the DeForest patent. I knew that the General Talking Pictures Company had reproducing equipment in the field after they acquired the patents. I do not recall that I had any knowledge of their having anything in the field before they acquired the patents.

1407

Q. But you knew they had some reproducing equipment in the field after they acquired the patents at this second conference that you referred to in the discussion with Mr. Schlesinger?
A. I don't know whether it was the second conference. At a later conference, I had knowledge of it.

I knew that that equipment in the field employed amplifying apparatus. I knew that the equipment of the General Talking Pictures was being used in reproducing the same films that our licensed exhibitors were reproducing.

Q. As a matter of fact, you knew just exactly

1408 *John E. Otterson—For Plaintiffs—Rebuttal—
Cross.*

what the system employed by the General Talking Pictures was, didn't you?

Mr. Ashton: When was this, Mr. Darby?

The Court: This was after the interview.

A. Well, I cannot say that I personally knew exactly what it was, no. It was known to our organization. I knew that the equipment employed amplifiers. I knew that they were vacuum tube amplifiers. I don't know at what time I knew by whom the amplifiers were manufactured; it was later.

Q. How did you understand that people in your organization gained information as to what equipment the General Talking Pictures Corporation employed?

Mr. Ashton: Mr. Darby, I will object to that. And I will say that we have already stated that the first information the patent department had was in April, 1929, and I believe you will—

Mr. Darby: Just a minute, this is cross examination. May I have the privilege of stating that if there is an objection to the question that counsel just state the objection without making any other statement.

Mr. Ashton: I object to the question. This witness has already testified it was later on—

Mr. Darby: Just a minute, please. I submit he should state his objection and the ground, without making any further statements.

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John E. Otterson—For Plaintiffs—Rebuttal—1411
Cross.

The Court: Yes, I think you better follow the practice.

Mr. Ashton: I object to the question on the ground that the witness has already stated—

Mr. Darby: That is argument.

The Court: What is there that is objectionable to the question?

Mr. Darby: Is it irrelevant or immaterial, what is your basis for the objection? 1412

Mr. Ashton: My objection to the question, your Honor, is that this witness has already testified that it was later on.

The Court: I don't think that is a proper objection; it is overruled and exception.

Mr. Darby: Will you please read the question?

(Question read.)

Q. Was it by an inspection of the apparatus?

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Mr. Ashton: Will you please let him answer the question before you suggest an answer?

The Witness: I assume that it was by an inspection of the apparatus. I don't know whether they had other means or not.

I have no recollection of Mr. Schlesinger ever having told me that he was employing Amer. Tran amplifiers. I deny that he ever told me that to the extent that I have no recollection of it. I have no record of it in my files, of his

1414 *John E. Otterson—For Plaintiffs—Rebuttal—Cross.*

making any such statement. My testimony is based exclusively on what is contained in my files and my own recollection.

I never offered to buy any General Talking Pictures equipment from Mr. Schlesinger or the General Talking Pictures Corporation. I did not offer \$300,000 for 300 General Talking Pictures reproducing machines. I am sure of that. I never offered Mr. Schlesinger to buy out Mr. Schlesinger or the General Talking Pictures Company.

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The Court: Just a moment, Mr. Darby. Will you please ask the witness if he had any familiarity with the royalty returns made by the American Transformer Company?

By Mr. Darby:

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Answering the Court's question, I had no knowledge. I did not personally take any steps to find out. Whether our legal or patent department did, I cannot say. I have no knowledge of their having done so.

Q. As a matter of fact, under the pooling arrangement of the patent rights of the American Telephone and Telegraph Company, and Western Electric Company, the Radio Corporation of America and the General Electric Company, the Radio Corporation was put in managerial control of the license system, was it not?

Mr. Ashton: I think the agreement speaks for itself, your Honor.

John E. Otterson—For Plaintiffs—Rebuttal—
Cross.

1417

The Court: I think you asked the witness a few questions on the license agreement matter and I think the other side might have the same privilege.

Q. Do you understand the question?

The Witness: May I have the question?
(Question read.)

Mr. Ashton: I would like to point out, 1418
your Honor, that these are different agreements from the ones we referred to before. These agreements that had to do with the Amer Tran license and not between the Telephone Company and Electrical Research Products.

The Court: I will confide to you, Mr. Ashton, that I would like to hear an answer to that question.

Mr. Ashton: That is all right, your Honor.

The Witness: I think I would like to 1419
have an answer to it myself. It is a rather involved question.

By Mr. Darby:

I know of the patent pool agreements between the General Electric Company, the American Tel. and Tel. and Western Electric Company and others.

I know that under the pool of patents, certain licenses were granted by the Radio Corporation of America.

Q. Now, you know under the pooling arrange-

**1420 John E. Otterson—For Plaintiffs—Rebuttal
Re-direct.**

ment, the Radio Corporation of America was put in managerial control of the licenses which were granted by the Radio Corporation and its affiliated companies, do you not? A. They were not in control of any royalties payable to us—any managerial control.

Q. I understand that, but they were in managerial control with regard to collection of all royalties that were to be paid under the licenses, which the Radio Corporation granted, with the consent, approval and joinder of the other members of the pool? A. They were in managerial control of the royalties which they collected under licenses, collected by them under the cross license agreement.

When I say licenses granted by them, I mean to include those licenses in which the Telephone Company likewise joined with the RCA as a licensor.

Where the RCA granted the licenses, they had the responsibilities of collecting the royalties.

1422 But there was no pooling as to the royalties. There was no division of the royalties between them. When you say managerial control, it did not relate to the two parties to the cross licensing agreement. They had managerial control of their own business, not ours. And our business, as far as granting patent rights and licenses are concerned.

Re-direct Examination by Mr. Ashton:

These recording licenses referred to in my statement read to me by Mr. Darby were talking motion picture recording licenses.

Harry G. Knox—For Plaintiffs—Rebuttal
Direct.

1423

HARRY G. KNOX, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is Harry G. Knox, I am vice-president of Electrical Research Products, Inc. I have been connected with Electrical Research Products and the Western Electric Company since 1927.

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Mr. Schlesinger stated yesterday that I made a statement, implied in my answer as follows: page 389 of the minutes,

"I am just trying to recollect the incidents, they came so fast and furious, in those days, and it is so far back. I am trying to do the best I can. Well, particularly after my return from a European trip, and about the time that Mr. Knox, another of the officials of the Western Electric Company or Electrical Research Products Corporation was about leaving for England, Mr. Knox called on me at my office and we had a talk about the amplifier that I was using, and he said, 'You are lucky to have a licensed amplifier'."

1425

I do not recall making that statement to Mr. Schlesinger at any time.

The Court: Will you just wait a minute. What was the date of that conversation,

1426 Harry G. Knox—For Plaintiffs—Rebuttal
Direct.

Mr. Ashton, please! Do the minutes disclose the date of the conversation between Mr. Schlesinger and Mr. Knox?

Mr. Ashton: The reference which I have, that is the reference at page 387 where it says it was 1927, then below this part that I just read to Mr. Knox on page 389 it apparently is 1929. That was the reason I was not definite in my question regarding it. It was not clear to me.

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The Court: Just what was the question, read it to me, please.

(Question read.)

By the Court:

I remember calling at Mr. Schlesinger's office either before I went to Europe in 1927 or after I returned in 1929. I cannot state the date. I think I returned in September, 1929.

1428

I recall vaguely the conversation that took place when I made that call. I was the European manager for Electrical Research Products, when I was abroad, and in that capacity, was interested in the potential territory of South Africa, in which country Mr. Schlesinger was influential and owned or controlled a number of motion picture theatres, which I thought might be potential users of our reproducing equipment. I think he also discussed the patent situation as regards Europe.

The availability of our equipment for use in South Africa was the primary object of it. That is what we talked about. I do not remember that we talked about his use of the American Trans-

*Frank N. Waterman—For Plaintiffs—Recalled— 1429
Rebuttal—Direct.*

former amplifier at all. We might have. It is entirely possible.

By Mr. Ashton:

I do not think that the solicitation of business on our part for our reproducing apparatus for South Africa had any relation with what Mr. Schlesinger may have been doing in the United States.

1430

Cross Examination by Mr. Darby:

Q. You also saw Mr. Schlesinger in London, didn't you? A. I think so, yes.

Q. And you knew, did you not, that Mr. Schlesinger had talking motion picture equipment which was being used or put out under the name of General Talking Pictures? A. Yes.

Q. And you knew that that apparatus employed amplifiers of the American Transformer Company, didn't you? A. Not necessarily American Transformer Company. I knew that he did not manufacture amplifiers, but I do not think I knew where he got them unless he told me so, and I do not recall that.

1431

FRANK N. WATERMAN, resumed the stand.

Direct Examination by Mr. Ashton (Continued):

Q. Will you continue, please. A. If now we assume that a signal is received on the grid

1432 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

which is such as to decrease the negative potential—in other words, the signal moves the bias or the instantaneous potential of the grid to the right from the point just indicated—then if the voltage on the plate of the tube remain that indicated by the curve 7, the current would rise following that curve, say to a point opposite the number 7 for a voltage indicated on the horizontal scale by the point perpendicularly below.

1433 But as soon as the current started to rise there would be an absorption of voltage in the load, so that instead of rising on the curve 7 it would, for instance, arrive only at the point on the curve 6 immediately under the point on the curve 7 which it otherwise would have reached.

It would therefore in effect have followed the dotted line marked a instead of following the curve 7; because when the current rose by a certain small increment there would be at first absorption of voltage, and therefore reduction of the actual voltage experienced by the plate. So as the current increased with the reduction of the negative bias, it would for a given plate circuit impedance have followed the curve a; and, by the same process, we could develop the curve a as far to the right as we chose.

Similarly, if the signal applied to the grid were such as to increase the negative potential upon the grid by a corresponding amount, the current would if the potential of the curve 7 was maintained, have fallen on that curve. However, when the current falls the potential consumed in the external circuit is reduced; therefore, the potential which actually reaches the plate is increased, and therefore as the grid became more

*Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

1435

and more negative the current instead of falling as rapidly as called for by the curve 7 would travel down the dotted line of the curve a and eventually a current value would be reached correspondent to a point on the curve a. Dropping a perpendicular from that point onto the horizontal line we find the grid voltage at which that would occur.

The effect of these changes in effective plate voltage as the result of the alternating current plate circuit impedance, the external circuit, is to straighten the characteristic; that is to say, it takes out the curvature to a greater or less extent, and if the external impedance is high enough with relation to the internal alternating current impedance of the tube the curve becomes practically a straight line over a large region. The actual useful range of the tube for the reception of signal is increased; at the same time the possibilities of distortion due to the introduction of harmonics is decreased.

1436

Q. Will you state, Mr. Waterman, whether you find the invention of this patent in the preceding patent, that is the 1,329,283, patent, on the question of double patenting? A. No, the patent 1,329,283, makes no disclosure whatever as to the effect of external load upon the shape of the characteristic. It goes wholly to the question of power output when the circuit and tube are organized in a certain way as set forth in the claims.

1437

Q. Will you take up as briefly as you can the several patents which were relied upon against this Arnold patent, starting with 1,114,845, Tab 8? If it will help you any I will give you the list.

1438 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

right now. A. If you would give me one at a time it would be just as well.

Q. Then take Patent 1,114,845. A. Patent 1,114,845, to Arnold is what is known in the vernacular of the art as a blue glow preventer.

Q. The same thing that is meant by blue haze?
A. Blue haze, yes.

By the Court:

1439

Q. That has to do with the action of the electron? A. It has to do with the setting up of a state of permanent ionization, the first ionization, by collision as it is called. The electrons knock off other electrons from atoms of gas in the tube.

By Mr. Ashton:

1440

Q. It is a gassy tube? A. A gassy tube. The early tubes were mostly gassy. When the ionization by collision has proceeded to a sufficient extent the electrons given off by atoms in the gas become sufficiently numerous to disrupt other atoms, and so the process, so to speak, becomes contagious and self-perpetuating. Then the tube is filled with a blue haze or glow and ceases to function. The condition in which the audion ceases to function is the condition in which the Von Lieben tube that we have been discussing normally functions. That condition may be brought about by an abnormally strong signal applied to the grid, by a change of brilliance of the filament, by a change of plate voltage. When those things are constant it usually comes about

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1441

by reason of the strength of the signal, or sometimes merely getting one's hand close to the tube. Since the tube instantly goes out of action when that occurs, it is desirable that it should be interrupted as soon as possible. One well known way of doing that was to reduce the plate voltage, and in the detectors of those days when I was working with these tubes it was customary to have a switch whereby the number of batteries in the plate circuit could be quickly varied, and if the blue glow appeared throwing the switch to a lower battery voltage would cause it to cease, and in receiving messages, which in my reception in those days was the only thing there was to receive, and telegraphic signals, we would lose a letter in a message while that was happening, at least.

1442

The Arnold patent inserts a resistance 8 into the plate circuit. The purpose of that resistance is this, if I may refer to the characteristic curve of Exhibit 24 to illustrate what I mean. The normal change of grid potential on this curve, equal to, say, an eighth of an inch, would give rise to a change of current equal to the corresponding ordinate, which is $3/16$ ths perhaps; but if this condition of blue glow occurs, the current no longer followed that curve but shot straight up. That current flowing through the resistance 8 caused the absorption of a large voltage. The actual voltage on the plate was reduced and the ionization died out. Therefore this resistance was able to automatically discontinue the blue haze. The action is not instantaneous, but it is rather quicker than one can manipulate a switch.

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1444 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

In order that that resistance should not affect the signal, however, it is shunted by a condenser 9, so that the alternating current passes through 9 chiefly, and then through the transformer 6. Therefore, so far as the normal functioning of the tube is concerned the resistance 8 is not there. But when the blue haze appears and with it the sudden great rise of current, that being a direct current flow, it chiefly traverses resistance 8. Insofar as it is purely direct current it wholly traverses 8; only a transient effect is experienced by the condenser 9. I think we need not go into the question of what transient effects are.

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Therefore the circuit normally performs as though no resistance 8 were there, and for the purpose of the signal the resistance 8 has no characteristic straightening effect whatever.

By the Court:

1446

Q. How does the resistance 8 learn that it is called upon to function? A. The resistance 8 is a part of the direct current circuit. The direct current is always flowing through the primary coil of transformer 6 to the resistance 8, through the plate across the tube and back to its source. When the resistance in the tube is decreased, then a larger part of the total battery voltage exists across the transformer primary and across the resistance. That gives rise to a large current.

The easiest way to look at those things, your Honor, is to recognize that the battery 7 creates a difference of potential, 50 volts let us say. A current starts out from the battery at a voltage

Frank N. Waterman—For Plaintiffs—Recalled— 1447
Rebuttal—Direct.

of 50 volts, with reference to the negative end. By the time it gets back that 50 volts is all gone. Some of it has been lost, only a small part probably in the primary of the transformer 6, some of it has been lost in the resistance 8, the rest has been expended in creating the space current in the tube, that is, in pulling the electrons across. If now, due to the creation of a large number of positive ions as the result of knocking electrons out of the atoms, the tube resistance is greatly decreased, say to one-tenth or one one-hundredth what it was before, then a much larger current must flow in order that that same 50 volts we assume on the battery may be consumed. That will mean a rise of current all through the circuit, an increased loss of voltage in the resistance 8, therefore a reduced voltage, a reduced electron velocity, in the tube itself, and a dying out of the state of ionization.

The alternating current flowing from the plate let us say through the circuit comes to the division point between resistance 8 and a condenser 9. It is going to take the easiest path. If it should by any chance make a mistake and choose the resistance, that current which had by accident gone through 9 would come out with a higher voltage at the junction point, and that is impossible. The same point cannot have two different voltages. Therefore what the alternating current does is to go through the condenser primarily, and only enough alternating current is sidetracked around through 8 so that the voltage at the two ends of that parallel net mesh have the same voltage. That means that a very small part will go through 8 and a large part

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1450 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

through 9, if the resistance 8 is large as compared to the impedance at 9.

Q. When it comes out of 9 it is partially direct, isn't it? It has been partly converted into direct, hasn't it? A. No, the alternating current never changes its character.

Q. It still has alternating pulsations, but the ripples are smoothed out, aren't they? A. No, I think not, your Honor. Insofar as there has been some loss of voltage in the condenser 9 the ripples are less high than they were before; they have been smoothed out in that sense, but they have not been changed in character.

Q. It becomes uni-directional, doesn't it? Isn't that the office of it? A. No, the alternating current goes through in either direction perfectly well.

Mr. Ashton: It is not a rectifier, your Honor.

1452 The Witness: No, it has no rectifying effect whatever. The tube itself is uni-directional in its carrying capacity; that is to say, using conventional terminology, current in the tube can only pass from the plate to the filament, and not in the reverse direction. That is why it is necessary to have flowing through the tube all the time a direct current, so that the alternating current coming out is really in effect only represented by an increase and a decrease of a direct current. The actual current through the tube is the same. But when we come to the transformer, the direct current will have no effect in the secondary transformer, but every variation of it, that is all

Frank N. Waterman—For Plaintiffs—Recalled 1453
Rebuttal—Direct.

of its alternating current part, will reproduce itself in the secondary of the transformer, and the transformer therefore serves to separate the direct current from the alternating current in the plate circuit. That is one of the proofs that we are correct in looking upon the varied direct current as a constant direct current plus a varying alternating current.

I perhaps ought to refer to Fig. 3, although I do not remember that Mr. Cloud did. In that instance the resistance 8 is used as part of the parallel feed, and the alternating current path is through the condenser 12, the upper condenser 12, through the primary of transformer 6 and the lower condenser 12. In this instance the resistance could not in any event have any effect upon the characteristic, because it is in a parallel circuit. The only effect which it has is to reduce the impedance of the load circuit. If the resistance 8 were infinite it would have no effect whatever; being finite, the larger it is the less effect it has. Therefore in no case could a resistance located as in Fig. 3 have the resistance straightening effect. That is true of both, parallel to each circuit.

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1455

By Mr. Ashton:

Q. Now the Pierce Patent 1,127,371. That is a patent, is it not, which takes advantage of the gas in it and the unstable characteristic which results? A. That is certainly true as to Fig. 1. I believe it is intended to be true also as to Fig. 2, because the patent states on page 1, line 20, that the apparatus is that illustrated and de-

1456 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

scribed in the preceding patents, and goes on to say "apparatus for amplifying or detecting electrical variations, a body of gas in an evacuated tube is maintained in a sensitive conducting condition, by means of an ionizing agency such as a hot filament or the mercury arc." The mercury arc produces the positive and negative ions and is a state of self-perpetuating ionization. The tube of Fig. 1 maintains a continuous arc.

1457 As I understand the specification the same method of operation is set forth for Fig. 2 as for Fig. 1. In Fig. 1 we have a mercury arc formed between the cathode 6, which is a pool of mercury, and the anode 5, and it is connected in a characteristic arc circuit. A source indicated as a battery A supplies current through an inductance, and the resistance to the anode, and the current flows thence across the space and makes the travelling bubble that we are probably all familiar with in these mercury tubes. That combination of unlettered inductance and resistance is known as ballast, and it is necessary to keep the arc from running away.

1458 The arc goes through a peculiar cycle. The current rises as the voltage is increased. Then suddenly a change takes place and the current rises while the voltage across the arc decreases. That is an uncontrollable state, unless there is in the external circuit a ballast, and that consists of two things, a resistance which is what is known as a dead resistance, and an inductance which is what is known as a live resistance and which operates by virtue of its stored energy. Those enable the arc to be controlled at some desired point.

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1459

What Dr. Pierce does is to rob that space of some of its ions and cause them to flow in a circuit including the anode 2 at the top of the tube, and they constitute a current flowing through the wire 30, the resistance 39, the relay 51, the telephone 40, the relay 32 back to the battery, the circuit being completed by the wire to the left of the battery, and up through the mercury column in the spacing of the tube. That stream he controls by a grid device 3 in response to radio frequency signals coming in by way of the antenna 20 and the transformer 22, 23. As they come in they pass through the condenser 27 and are rectified in the tube, because this tube also conducts only one way, leaving the condenser charged.

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Two things representing opposite extremes in that operation may happen. In the first place the arc or the stream established, stream of positive ions established in the path between the anode 2 and the mercury pool 6, may itself follow the curve with this peculiar course which I have indicated, and if the current gets past that critical point it would result in blowing up the whole apparatus. The current would go to uncontrolled heights and the tube would explode. Therefore he has a ballast in that circuit 2 also; namely, in the circuit connecting anode 2 to the battery by wire 30, and the relays and telephone, that ballast is 39.

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Referring to page 2, line 47, it is stated, "the circuit 30 may be provided with a ballast resistance 39." The reason why it only "may be" is that the resistance and inductance in the circuit may of themselves be sufficient ballast, but

1462 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

if not then resistance enough to prevent the destructive running away of the arc is included.

The same description applies to Fig. 2, as I understand it, except that there is not the extreme danger of explosion in that case than there is in the other. There would be, however, a complete inoperativeness if the current got to the runaway part, and therefore a ballast 39 is shown in that case. This has to do merely with

1463 the reception of telegraph signals. The straight line characteristic is of no consequence, it would not be recognized if it existed; and as a matter of fact the ballast resistance required would not ordinarily be at all comparable with the internal resistance of the tube. It is in fact relatively small. There are very definite rules for working that out, but in general a ballast resistance is not at all the same thing as a characteristic straightening resistance.

Q. Does the operation of the patent depend upon the change of the tube from stable to unstable operating condition? A. Yes. I neglected to state the other extreme that I believe Mr. Cloud did refer to, resistance 62 also, and I perhaps ought to state that. If a very heavy signal comes into a tube of this sort it may put so large a charge upon the grid as to cut off all flow of current or to reduce it to a prohibitively low point. If the condenser 27, for example, acquired such a charge and cut off the flow, then the receipt of the signal would be interrupted. I should point out to your Honor that the relay 32 works through a local battery, a sounder 34, so that the operator reads the signal by the ordinary click.

Frank N. Waterman—For Plaintiffs—Recalled— 1465
Rebuttal—Direct.

ing sounder, such as we are accustomed to hear in telegraphic offices; or in the event that the dots and dashes should not be sufficiently strong to operate the sounder, the operator may put on the headphone 40 and read them by sound.

The patent states, referring to page 1, line 51:

"It is found, however, that when the apparatus is adjusted so that it will be sensitive to feebly received oscillations if stronger oscillations are impressed on the controlling circuit there will be an appreciable time lag before the tube recovers its normal conductivity."

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In other words, the current is chased down on the curve of the tube, whether it is this shape or not—chased down toward the cut-off point.

"This is believed to be due to an accumulation of a sufficiently great negative charge on the screen and condenser caused by the rectification of the impressed oscillations, so that the charge is not dissipated from the screen for an appreciable time."

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By the Court:

Q. Does he mean grid, "screen"? A. Yes, he mean grid. Therefore he includes in the circuit a relay 51, in the plate circuit, which is held attracted by the magnet of the relay when the current is of a desired normal intensity. If the current is reduced too low or altogether cancelled out by the negative charge received on the

**1468 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.**

condenser, it releases its armature and makes a back contact.

In Fig. 1 the back contact merely short-circuits the condenser 27, thereby relieving it of its charge. In the case of Fig. 2 it shunts it by a voltage derived from the battery 61, so that instead of being returned to a zero voltage it is returned to any desired voltage. The passage which I just quoted refers to adjusting of the tube to feeble oscillations. That used to be done in the case of tubes such as in Fig. 2 by the temperature of the filament very largely, and the tube could be brought to a state where a signal coming in would momentarily drive the curve up on this rise, and yet it would come back again, the rise being not actually vertical but sloping into a vertical. For the reception of feeble signals that was the most sensitive condition under which you could work. It was very critical. That is what Dr. Pierce means when he says "adjusted sensitive to feeble oscillations." Then if a stronger oscillation comes in, it could have one of two effects, whichever it reached first. It could shoot the current up on the curve of gas action or it could plug the condenser. Whichever happened first would get control. Therefore he controls both ways.

By Mr. Ashton:

Q. In this next patent 1,129,943, Tab 11, it is true as Mr. Cloud admitted, I believe, that the resistances 8 in both figures are coupling resistances, is it not? A. That is true.

Q. Is there any disclosure as to the resistance

Frank N. Waterman—For Plaintiffs—Revised— 1471
Rebuttal—Direct.

of the tubes in this patent? Might they be high voltage tubes? A. They are indicated as high voltage tubes. I have been assuming all the time that they were high voltage tubes.

Q. If they are high voltage tubes may their resistances be as much as several hundred thousand ohms? A. Oh, yes.

Q. Now will you refer to the Colpitts Patent 1,137,384, tab 13. As I understand it this is a modulator, is it not? A. It is a combined generator and modulator. It relates to the transmission of signal, and in each case the tube is used in the double capacity of generator of high frequency oscillation and modulator thereof. That means the necessity for critical adjustments. If I recall correctly Mr. Cloud referred chiefly to Fig. 2 and to a symbol therein appearing immediately at the right of the condenser 8 in that figure. This he called a resistance. However, it is not described as a resistance and it is shown in the same way as the coils. In other words, the patentee here does not discriminate in his symbolism between parts which he describes as resistance and parts which he describes as coils.

The natural thing to expect of Fig. 2 is that the symbol at the right of the condenser is an inductance and that together with the variable condenser 8 it constitutes a tuning inductance. To make that clear would involve perhaps a rather long explanation, but I may perhaps short-cut it in this way: a tube will act as a generator of oscillations if an amplified oscillation in its plate circuit is carried back and put into the grid circuit again. In other words, let us assume that something or other gives a

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1474 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

change of voltage to the grid 13 in Fig. 1, taking that as being the simplest figure. That impulse, whatever it was, will appear in exaggerated form in the coil 4 in the plate circuit of that tube. 4 is the primary of an oscillation transformer 6. That exaggerated impulse in 4 is repeated in 17, and from 17 it is carried back through condenser 18 to the grid 13, but acting on the grid it in turn creates a still more exaggerated impulse in the plate circuit because every impulse on the grid creates an impulse on the plate circuit.

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By the Court:

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Q. That is the office of the grid, is it? A. That is the office of the grid. So that that doubly exaggerated impulse again passes through the coil 4 and is again fed back to the grid. The result is that that process continues until the tube assumes a continuous state of oscillation. The question is what frequency will that oscillation have, desired to control it? That must be done by tuning a certain element; that is, by giving to some element a definite time period. Does your Honor understand what I mean by "tuning"?

Q. No, I do not think I do. A. Your Honor is acquainted with the fact that in mechanics a combination of a weight and a spring will oscillate at a given period. An inductance electrically corresponds to a weight. You can write the mechanical and electrical equations in parallel columns and they will be exactly alike. The

Frank N. Waterman—For Plaintiffs—Recalled— 1477
Rebuttal—Direct.

terms of one represent mass or weight and of the other will represent inductance. Capacity corresponds to a spring, the term which represents elasticity in a mechanical equation will represent capacity in an electrical equation. So if you combine inductance and capacity you have a system which will have the same strong preference for oscillation at a given frequency than a combination weight and spring has, as in the balance wheel of your watch. So all tuning in radio is done by determining in one way or another correct or desired relations of inductance and capacity.

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In Fig. 1 the condensers 8, 9 are variable, and they are tuning elements. That is rather imperfect. It is a very simple system, but rather an imperfect one. He goes on to make them more perfect in other figures. In Fig. 2, as I interpreted, he has that condenser 8 and a variable inductance along with it for his tuning.

Q. By tuning you might roughly say adjusting? A. Yes. He does exactly the same thing when you adjust the regulator of your watch, adjust the time period swing. The modulation is effected by simultaneously impressing on the input circuit the alternating current derived from a microphone. In Fig. 1 that is completely illustrated. It is only indicated in the other figures. The microphone is at 24. It is supplied by its local battery 23 speaking into the microphone, which superimposes an alternating current on the normal current flowing through the microphone. That alternating current is transformed in condenser 32 over into the secondary circuit coil 20, and passed on to the input trans-

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1480 *Herbert M. Wilcox—For Plaintiffs—Rebuttal—
Direct.*

former 15 from whose secondary 14 it passes to the grid. Therefore the tube is doing two things at once: it is oscillating, producing an oscillatory current; it is modifying that oscillatory current in accordance with the relatively slow changes due to the speech curves. The radio frequencies may be of the order of hundreds of thousands per second, whereas the speech frequency at the most are in the lower thousands.

1481 It is necessary that the apparatus should be very thoroughly adjustable in order that these generated alternating currents and the modulating audio current should be in correct relation to one another, and that accounts for the large number of adjustments that one finds in all these figures except Fig. 1. Fig. 1 is really just for the purpose of explaining what it is all about. The other figures show the numerous adjustments that are involved in getting those of the right relative magnitudes and of the right oscillation frequency.

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AFTERNOON SESSION.

HERBERT M. WILCOX, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is Herbert M. Wilcox. I am vice-president of Electrical Research Products, Inc.

Herbert M. Wilcox—For Plaintiffs—Rebuttal— 1483
Direct.

Electrical Research Products Company was incorporated on December 20, 1926. It was formed to commercially promote the use of the patents of the telephone industry in the commercial field, more particularly the Western Electric system of recording and reproducing sound for talking motion pictures. When I said "patents" a moment ago I meant patents. I mean developing patents.

An exhibition of Western Electric talking motion pictures occurred on August 6, 1926, in New York. It was very successful. It aroused widespread interest in the motion picture industry, and within two years, talking pictures were generally adopted by the industry as a whole.

I don't believe there were any theatres anywhere equipped with commercial apparatus enabling them regularly to show talking motion pictures with such apparatus at the time the Western Electric Company's apparatus was introduced to the public in August, 1926. I am not familiar with any. I knew of none. I would probably have known if there were any. Other companies had attempted to introduce talking pictures prior to that time. I believe Lee DeForest and DeForest Fonofilm had attempted to introduce them prior to that time. They had not been done in a commercially successful way. I am not aware that any motion picture producer, except Vitaphone, or prior to Vitaphone regularly produced and distributed talking motion pictures, prior to the introduction of the Western Electric system. The Vitaphone Corporation acquired its recording license from the

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1486 *Herbert M. Wilcox*—For Plaintiffs—Rebuttal
Direct.

Western Electric Company April 20, 1926. The Vitaphone Corporation granted a sub-license to the Fox Case Company, a subsidiary of the Fox Film Company, in December, 1926.

Electrical Research Products granted five recording licenses in May, 1928; Famous Players-Lasky Corporation; Metro-Goldwyn-Mayer; United Artists; Universal Pictures; and Firma-tone Corporation, which was a subsidiary of First National Pictures.

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An investigation was made by these producers before they took their licenses. A committee was formed to investigate various makes and types of sound recording and reproducing apparatus, which worked for nearly a year, I believe, and finally decided to adopt the Western Electric system. There was other apparatus which was being offered at that time in 1928. This is a correct list of the present recording licensees in the United States and foreign countries of Western Electric sound system.

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Mr. Ashton: I ask that the list be copied into the record at this point.

Mr. Darby: How is it pertinent or relevant?

Mr. Ashton: We want a record of the licensees of the Western Electric Company for the purpose of showing the use of Western Electric system, which embodies the inventions here in suit.

The Court: Is this a list of licensees prior to the date of the filing of the bill?

Mr. Ashton: I do not know whether

Herbert M. Wilcox—For Plaintiffs—Rebuttal— 1489
Direct.

that would require any change or not; most of these licensees continued from the time they first acquired their licenses. Maybe Mr. Wilcox could tell me, I don't know whether he could offhand, what differences there are in the list since September, 1929.

The Witness: I could not offhand, but there have been some substantial additions to it since that time.

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Mr. Darby: For the purpose of showing use, I do not think it is pertinent or necessary, but at any rate it should only include those before the filing of the bill. Even those prior to the date of the filing of the bill I do not see that it is relevant or material to any issue in this case.

*The Court: I am not able to say that it would be and I am unable to say that it would not be. Do you want that copied into the record as of September, 1929?

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Mr. Ashton: As of the present time, unless I misunderstood your Honor's ruling.

The Court: Is there an objection?

Mr. Darby: Yes, I objected and I understood your Honor overruled my objection and allowed me an exception. That was for any purpose whatever. As to those that were licensed prior to the filing of the bill, I of course adhere to the objection, and to anything subsequent to that time, but I do not see any necessity for delaying the proceedings, if Mr.

1492

Case.

Ashton will undertake to see that a correct list, corrected to date, is supplied to the stenographer.

Mr. Ashton: I would be glad to supply that if your Honor rules those are the only ones that may go in.

The Court: I do not see that the present list of licensees is pertinent, but if I am wrong in that, I would like to be informed.

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Mr. Ashton: That is merely to show, your Honor, the extent to which these inventions are used, so it is pertinent to show what concerns have licenses now.

Mr. Darby: My point is this: There is evidence in the case now that these inventions—or the inventions of these various patents have been used for transcontinental telephony, for transoceanic telephony, and we have at no time questioned the utility of the invention, and this is merely cumulative evidence on something that is not in issue or in dispute. I do not see that it is material at all.

Mr. Ashton: The particular use to which the suit is directed is talking motion picture use. I do not think, so far as the bill of complaint is concerned, that the other uses enter into the question of admissibility of the list.

The Court: I will overrule the objection and exception.

(The list referred to is as follows):

**LIST OF TALKING MOTION PICTURE RECORD-
ING LICENSEES OF ELECTRICAL RESEARCH
PRODUCTS, INC.**

United States

Audio-Cinema, Inc.
 Audio Products, Inc.
 Cinelog Corporation
 Columbia Pictures Corporation
 Eastern Service Studios, Inc.
 Firnatone Corporation
 Fox Film Corporation
 General Service Studios, Inc.
 Movietonews, Inc.
 Hal Roach Studios, Inc.
 Metro-Goldwyn Pictures Corporation
 Paramount Publix Corporation
 United Artists Corporation
 Universal Pictures Corporation
 The Vitaphone Corporation
 Western Service Studios, Inc.
 Jam Handy Picture Service, Inc.
 Wilding Picture Products, Inc.

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Foreign Countries

Associated Screen News, Ltd.	Canada
British & Dominion Film Corp. Ltd.	England
Paris Studios Cinema	France
Les Studios Paramount	France
Nippon Katsudo Shashin Habushiki Kaisha	Japan
Far East Film Laboratory	Japan
Fono Espana, S. A.	Spain
Fono Roma	Italy

1498 *Herbert M. Wilcox—For Plaintiffs—Rebuttal—Cross.*

Q. How many Western Electric motion picture reproducing systems are now in use in the United States and foreign countries?

Mr. Darby: The same objection.

The Court: Overruled and exception.

A. On December 31, 1933, there were 5,738 in the United States and 3,705 in foreign countries.

1499 The Western Electric Company amplifiers were used in public address systems in 1920, in connection with the Harding Inaugural. Our company uses its amplifiers for public address systems now. Some of the phonograph companies acquired licenses in 1924 for electric recording and electric reproducing—the Victor Talking Machine Company and Columbia Phonograph Company in this country.

1500 I witnessed an exhibition of De Forest pictures in the Fall of 1926, at their studio, I think it was on 48th Street. It was the Lee De Forest equipment there, I don't recollect whether it was the Fonofilm Company at that time or not. In my opinion, the results of that demonstration were very poor. At about the same time I heard and saw an exhibition of one of the De Forest new pictures on upper Broadway. My judgment in regard to the quality of that was about the same. I had experience in judging quality of sound pictures at the time I saw these exhibitions.

Cross Examination by Mr. Darby:

The first public exhibition of talking motion pictures with which I or my company was associated in 1926 was not that picture called

Herbert M. Wilcox—For Plaintiffs—Rebuttal— 1501
Cross.

"The Jazz Singer," that was the picture called "Don Juan." John Barrymore was the star in that picture.

Until the producers began making talking motion pictures, there was no available supply of talking motion pictures to be exhibited in the various motion picture theatres. I understood that the pictures that were exhibited with the De Forest equipment that I saw were pictures made in the De Forest Laboratory. I presume that the De Forest people, in endeavoring to promote talking motion pictures, not only had to supply the reproducing equipment, but had to supply the films themselves.

Q. Now, you have referred to a number of licenses that had been granted by your company to producers. Have you got a copy of the license agreement showing the terms under which the licenses were granted to the producers with you here in court or can you get a copy? A. I presume I can get a copy.

Q. I ask you to please do so.

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Mr. Ashton: I do not know upon what grounds that would be pertinent, your Honor. I have no copy here of that agreement. It is a form agreement. If Mr. Darby would state what the pertinency of it is; I don't know whether I should object.

Mr. Darby: I will gladly state what the purpose is. Mr. Ashton has put in evidence through this witness, a beautiful picture of commercial success in the talking motion picture industry in connection

1504

Case.

with the inventions here involved. The facts, as I can prove by this witness on cross examination are these: That licenses were granted to the producers; the producers were restricted by clauses in their contracts, not to permit the reproduction of the films that they produced, except on reproduction equipment acquired from the plaintiff. That explains the vast number.

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I likewise will prove that the restrictive covenants in the license agreements signed with the exhibitors or theatres precluded them from exhibiting on that machine any films that were not acquired from the licensed producers. In other words, it was the tie-up which formed the subject matter of the litigation in Delaware, and which I think, will paint an entirely different picture of the commercial success.

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The Court: I understood you to say previously that you did not dispute commercial success and that it is not an issue in the case.

Mr. Darby: I do, your Honor, and that is the reason I thought that this entire line of testimony should be excluded, but being in, I think the true facts as to why it has expanded to the point it has, should be brought out.

The Court: There would not be any finding appropriate on the subject, would there, in a decree entered in this case?

Mr. Darby: There would not be a finding appropriate to it, no, your Honor. At the same time, in explaining commercial

*Herbert M. Wilcox—For Plaintiffs—Rebuttal—
Cross.*

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success which is put in frankly for the purpose of bolstering up the patents,—if it is utilized for that purpose, it might reflect an erroneous conclusion.

The Court: Suppose you just call attention in your brief to the possibility of the erroneous conclusion on that subject.

Mr. Darby: Very well, your Honor, and for the purpose of any possible appeal record, may my last statement be accepted as an offer of proof?

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The Court: Yes, that is the way I understand it.

Mr. Darby: So it will not be stricken when the record is completed.

The Court: Very well.

By Mr. Darby:

Western Electric and Electrical Products do not produce pictures, Mr. Darby. The first pictures that were made were recorded on discs by this system. Western and Products produced the equipment and supervised the recording. And the equipment was essentially of the character of a synchronizing disc record with the camera record. And the De Forest records employed sound on film. Sound on film is used practically exclusively in the industry today.

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1510 Donald McKenzie—For Plaintiffs—Rebuttal—
Direct.

DONALD MCKENZIE, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

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My name is Donald McKenzie. I am staff engineer of Electrical Research Products, Inc. I have been employed by the Western Electric since 1920; by the Electric Research Products since December, 1929.

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I heard a demonstration of the De Forest talking machine pictures in a New York theatre in 1923. It was either the Rivoli or the Rialto, I forget which one. The De Forest pictures were shown at one theatre, and subsequently at the other, for a few days. They were demonstrations rather than talking pictures as we know them now. There was a talking picture but only a reel at a time. In my opinion they were by no means of good quality.

Three years later, in September, 1926, I saw Dr. De Forest and his staff in his laboratory, which Mr. Wilcox referred to a moment ago. The demonstration there was in the sense that we heard some records which had been made, and we, actually at De Forest's request undertook,—that is the only occasion I did myself,—to be present and supervise the acoustic pick-up of the record he was making. The following day I heard the results on film without the picture. Those results were terribly smeared as to sound quality.

I had had experience in observing quality

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*Donald McKenzie—For Plaintiffs—Rebuttal
Cross.*

prior to witnessing these exhibitions. Since 1922, we have been engaged in recording sound by electrical means in the laboratory, and I was myself in charge of the phonographic side of the sound film work. It was the Bell laboratories, then known as the engineering department of the Western Electric Company.

Cross Examination by Mr. Darby:

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This attendance by me at the Rivoli Theatre, was on my own initiative. I don't recall that this De Forest talking picture was advertised on the electric sign outside of the theatre. I saw it in the newspapers. I do not recall what motion picture star was playing there that night. It was not at night when I went there. This De Forest film was only one reel. I read in the newspaper that it was a special attraction; it was to play for a week. I paid admission to go to the theatre. I did not notice people paying admission, but there were many people there.

You have shown me what purports to be a photograph of the Rivoli Theatre and asked me if I can identify that as the theatre that I attended on that occasion. I cannot identify it. I never saw it at night. It is customary for the theatres to have the same signs in the daytime as at night, but when I went to the theatre, I did not look at the sign.

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By the Court:

The sign as shown on that picture does not refresh my recollection as to the name of the

1516 David Sarnoff—For Plaintiffs—Rebuttal—
Direct.

theatre. I don't know whether it was the Rivoli or the Rialto.

By Mr. Darby:

I do not recall whether the picture I saw on that occasion had Pola Negri as the star. I do not go to pictures just for the fun of it, I went there to see what De Forest had.

1517 I am employed as staff engineer of Electrical Research Products; there are a few such. The company is continually striving to improve the equipment that it produces. Naturally, we are at all times striving to improve the quality of the sound equipment produced by our company. We have, it is true, improved the apparatus, so that better sound can be produced today over what we had in 1927, but we do not ourselves produce it, and we do not control the licensee in all details. Our present apparatus is capable of better sound. I hope it is capable of much better sound than in 1927.

1518 better sound than in 1927.

DAVID SARNOFF, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Neave:

I am president of Radio Corporation of America. During 1928, I was general manager. In 1929, early, I was made executive vice-president.

*David Sarnoff—For Plaintiffs—Rebuttal—
Direct.*

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During the first half of 1929 I was in Paris with Mr. Young working on what subsequently became known as the Young Plan. That was embodied in an international agreement. I believe that we left to go abroad around the 1st of February, 1929, or the latter part of January and returned, I think, in the early part of June of that year.

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I know Mr. Max A. Schlesinger, president of General Talking Pictures Corporation. I have had interviews with him. Those interviews were at his solicitation. Mr. Schlesinger has testified here that he had some interviews with me in 1928, before I went abroad with Mr. Young. I don't believe I can fix the date with exact precision, but I think it was probably around that period. My recollection of the first interview that Mr. Schlesinger and I had, and I think that his brother was present at the first interview,—as I say, my present recollection is that that interview related to some interests that Mr. Schlesinger expressed in equipment which he wanted for South Africa where his brother was operating. We had several subsequent interviews. At the subsequent interview he told me what it was that he wanted to talk about. The discussions at the subsequent interviews, as I recall, related to his suggestions of a possibility of consolidation of the patent situation in the field which he said his interests controlled, with those with which Radio Corporation controlled. We discussed those possibilities at several interviews, and also, I think, at one of the interviews, a suggestion was made that we might purchase the interests of his company and consolidate them with

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1522. *David Sarnoff—For Plaintiffs—Rebuttal—Cross.*

the Radio Corporation. That suggestion was made by Mr. Schlesinger. Nothing came of those negotiations or interviews. I knew at that time that the Radio Corporation, together with others, including the American Telephone and Telegraph Company, had granted a license to the American Transformer Company, in certain fields, not including talking motion pictures. As far as I can recall, American Transformer Company or any

1523 of its apparatus was not mentioned in my interviews with Mr. Schlesinger. Mr. Schlesinger, purporting to state what was said at his interview or interviews with me, has testified in this case:

"Mr. Sarnoff said to me the American Transformer Company—I told him I had bought from the American Transformer Company the amplifiers which his people had known through investigation."

1524 I do not remember any such statement by him. Mr. Schlesinger further testified yesterday that I said to him in some of these interviews:

"Well, they are a licensed firm, and that is all right."

The "they" meaning the American Transformer Company. I did not ever say that to him. I am quite certain of that.

Cross Examination by Mr. Darby:

Q. At the time Mr. Schlesinger saw you and suggested a possible merger and whatnot, did

*David Sarnoff—For Plaintiffs—Rebuttal—
Cross.*

1525

you cause his situation to be investigated by any assistants of yours? A. I referred the matter to Mr. Schairer, the head of the patent department, who is one of my assistants, and asked for his views on it.

As to whether an investigation was made, as far as I know, I cannot answer that question definitely; it may be that Mr. Schairer may be able to. Mr. Schairer made a report to me. I do not recall in what form, but I recollect that it was negative. I assume that Mr. Schairer reached his conclusions, but I do not know whether it was as a result of an investigation or a study of the patent situation. I believe that Mr. Schlesinger did tell me at the time I had the conversation with him, and I did have a general knowledge that he had sound reproducing equipment in the field, I knew that apparatus was being used to project talking motion picture film that was being produced by the various producers in the United States. I would assume that that apparatus employed amplifying apparatus and vacuum tube amplifiers.

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I do not recall that during the conversation with Mr. Schlesinger, he told me, as one of the elements of his set-up, that he was employing amplifying apparatus that had been purchased from one of the RCA licensees. I do not recall during that conversation with Mr. Schlesinger, the subject of amplifiers came up for discussion at all. I do recall, however, that the subject of patents came up. That is, the patents owned by Mr. Schlesinger's company and the patents owned by my company.

I recall, I think at our last interview, that I

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*David Sarnoff—For Plaintiffs—Rebuttal—
Cross.*

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asked Mr. Schlesinger, in response to or after he had made the statement of his patent situation as to whether he really believed that he could continue to produce his apparatus in that field without a license under any of the patents of the Radio Corporation or General Electric or Westinghouse or the American Tel. & Tel. or Western Electric, under all of which my company was licensed, whether he thought he could continue without infringing those patents. And I recall his statement that he believed that he could do so without infringing the patents. I also recall asking him whether it was his position that our system on the other hand infringed his patents, while his system was free from infringing any of our patents, and I recall his statement to the effect that he so believed. I recall that, because it made a very profound impression on me. I don't recall his telling me that the amplifying apparatus that he was employing was licensed by the Radio Corporation, or acquired from a Radio Corporation licensee. I do not recall our discussion having been broken down to any sub-division of the problem. I recall in particular, the broad question and his general response. I do not remember our discussion as to any circuits, devices or anything of that sort.

As to whether Mr. Schlesinger told me on what he based his belief that he could continue without infringing any of the patents owned by Radio Corporation or its associated companies, I don't believe he did, and I do not believe I asked him, because I do not regard Mr. Schlesinger a patent expert, and I am not one myself.

*David Sarnoff—For Plaintiffs—Rebuttal—
Re-direct.*

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By the Court:

I do not recall sending any of our engineers to Mr. Schlesinger's studio for the purpose of investigating his equipment.

I do not recall issuing orders to any of my associates or subordinates to do that.

I have no recollection of any report from any of my subordinates based or purporting to be based upon an investigation of his equipment in his studio, but I do recall a report from Mr. Schairer, and all that I retain of that report is the general conclusion. I do not recall that that report contained any observations made by engineers concerning the nature or character of the equipment employed in the Schlesinger studio. If I may add, I do not recall now whether the report which Mr. Schairer made to me was a written or an oral one, but it has been my general custom to talk these matters over with Mr. Schairer.

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Re-direct Examination by Mr. Neave:

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The report of Mr. Schairer was on the General Talking Pictures patents.

The RCA Photophone is a wholly owned subsidiary of the Radio Corporation.

If the RCA Photophone was looking for or desired to have additional studio space, and if their representatives went around to examine premises to look for such studio space, that is not a matter that would normally come to my attention. It might come to my attention, but ordinarily it would go to the executive vice-president of the field in charge.

1534 *Otto S. Schairer—For Plaintiffs—Rebuttal—*
Direct.

Re-cross Examination by Mr. Darby:

From my recollection and knowledge of what is done by my assistants in connection with the matter, I am not in a position to deny that engineers of the Radio Corporation did inspect the equipment of the General Talking Motion Pictures Company.

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OTTO S. SCHAIRER, called as a witness on behalf of the plaintiffs in rebuttal, having been first duly sworn, testified as follows:

Direct Examination by Mr. Neave:

I am the vice-president of the Radio Corporation of America. I have held that position since the Spring of 1930. My duties in that position included and do include the formulation and recommendation of policies with reference to the granting of licenses by the Radio Corporation.

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There have been put in evidence here the 1920 and the 1926 cross license agreements between the American Telephone and Telegraph Company and the General Electric Company, and the extension agreements to the Western Electric Company and the Radio Corporation, and also the license from Radio Corporation, American Telephone and Telegraph Company, General Electric Company and Westinghouse Company to the American Transformer Company. I am generally familiar with those various license agreements, but I am not especially familiar with the American Transformer license. I knew

Otto S. Schairer—For Plaintiffs—Rebuttal
Direct.

1537

there was such a license. I know that was a restricted license, not for the use of talking motion pictures.

Q. In all these agreements that I have just referred to the licenses were restricted to specified fields of use. Will you tell us from the standpoint of the situation of the Radio Corporation of America why licenses granted by it were restricted to use in specified fields? I want to bring out facts from which it may be judged whether such restrictions were arbitrary or whether they were reasonable. I am not asking you for your conclusions; I am just asking you for the facts.

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Mr. Darby: I object, if your Honor please. I think the reasons for it are wholly immaterial. The fact is they were so restricted, and I think that is the end of our inquiry. Whether it was arbitrary, just or unjust I think is not before the Court.

1539

Mr. Neave: We are dealing here with licenses restricted to certain fields. I wish to know from Mr. Schairer the business considerations back of such licenses and upon which the licenses were based. I do not ask him to state whether they were reasonable or unreasonable.

The Court: You do not ask him to construe the licenses in the sense that you expect him to say whether the purposes that he had in mind were actually reflected in the agreements or not; is that it?

Mr. Neave: No, that is perfectly true.

1540 Otto S. Schairer—For Plaintiffs—Rebuttal—
Direct.

I have called his attention to these licenses merely as licenses of a class, restricted to certain fields. I do not expect him to discuss these particular licenses or any other particular licenses. Just as a business proposition, one of policy, what are the facts with reference to the granting of licenses restricting the use to certain fields.

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The Court: It seems to me, Mr. Darby, that it might be helpful in reaching a conclusion on this branch of the case. Perhaps it would not be. Perhaps all that would be accomplished would be consuming a little extra time and a little extra space in the record, and I do not think there would be any harm done to the defendant.

1542

Mr. Darby: No, I am sure there will be no harm done; but the only point of my objection is that we are not concerned with why it was done. The fact is it was done. The Court must decide whether that is legal or illegal, irrespective of why it was done.

The Court: I might almost suspect that your objection was sound, but I am going to overrule it, with exception.

Q. Mr. Schairer, you know what I have in mind. Start with the purposes for which the Radio Corporation was formed. A. The Radio Corporation was formed originally—

Mr. Darby: May I go one step further, if your Honor please. We are going to

Otto S. Schairer—For Plaintiffs—Rebuttal—
② Direct.

1543

run into exactly the same situation that we did a moment ago.

The Court: We have not moved very far in the moment.

Mr. Darby: No, but we have started with why the Radio Corporation was formed. That is absolutely going to necessitate my bringing into this record to complete the story of the picture this entire anti-trust litigation in the Delaware court, the Government suit and the Government decree.

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The Court: I do not think so. I think you might be satisfied with the explanation, and you might not care to contest it.

Mr. Darby: No, sir; because the reason is this—

The Court: If you do not, I do not see how your cause is affected.

Mr. Darby: The cause is not affected, but it is being utilized to paint a picture that cannot withstand illumination, your Honor. It is exactly the same story they tried to tell in the Government case and exactly the same story they tried to tell in the Wallerstein litigation.

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Mr. Neave: Perhaps you misunderstand. He is not going to tell that story again.

The Court: All right, tell us.

The Witness: The Radio Corporation was formed originally to engage in the business of communication for tolls. That for a time was its primary business. When the corporation undertook to grant licenses it was not considered

1546 Otto S. Schairer—For Plaintiffs—Rebuttal—
Direct.

advisable for it to grant licenses in the field of communications for tolls, because in that business we were competing with cables and wires, and our patents constituted the only substantial measure of protection we had for that new business. Our developments over all these years have been in the direction of improving the quality and reliability of that communication service, and to the degree and extent to which

1547 we have been able to improve that service thereby we have not been willing to grant licenses to others in that field. In other fields, such as for amateur, experimental and broadcast reception, we have granted licenses and they have been restricted to those fields in order, first, that the licenses might not engage in competition with our communication business, and also such restricted licenses have not authorized the licensees to sell that kind of apparatus for use in theatres, for instance, where the benefits obtained from the use of the inventions have been

1548 much greater than could possibly be represented by a reasonable or moderate percentage of the selling price of the apparatus such as we were satisfied with upon licenses granted for amateur, experimental and broadcast reception. In that latter field the only practical way to satisfy the demand of the public is to sell the operators outright, and in that case the only reasonable or practical measure of the value of the inventions is to accept a percentage of the selling price as a royalty.

These things, these vacuum tubes and the circuits on which we have patents, are useful in various of these fields and applicable to many

Otto S. Schairer—For Plaintiffs—Rebuttal
Cross.

1549

fields. And if we granted licenses not restricted to any particular field, the same things could be used in these other fields. So under those conditions we could not afford to grant any licenses at all in the field of communications for tolls unless they were so restricted, we considered we could not afford to do it. Nor could we grant licenses if the apparatus made under those licenses were free to be used in those fields.

And that applies to some of the other phases of our work that we have to do with. What I have stated is merely illustrative.

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Cross Examination by Mr. Darby:

When I refer to "our patents" I am referring primarily and in the first instance to those of the Radio Corporation.

In addition to those, the patents under which we have the right to grant licenses which include the patents of the American Telephone and Telegraph Company in some fields, the Western Electric Company in some fields; Electrical Research Products in some fields; Westinghouse Electric & Manufacturing Company, and the General Electric Company in some fields in each case.

1551

Between the years 1927 and 1930, we had the right to grant licenses under our own patents in the field of talking motion pictures. Under the patents of the Telephone Company, only for amateur, experimental and home use. Not for use in theatres under the Telephone Company's patents. Never have had that right. And if Mr. John E. Otterson testified to the contrary I disagree with him.

1552 *Otto S. Schairer—For Plaintiffs—Rebuttal—
Cross.*

By the Court:

I do not recall having instructed any of my subordinates, or our engineering staff, to visit the studios of Mr. Schlesinger with a view to examining the reproducing apparatus there employed, and I don't believe it would have been within my jurisdiction.

1553 I did not make a report to Mr. Sarnoff concerning Mr. Schlesinger's patents and scope and so on of the patents that he controlled, early in 1929. I didn't join the staff of the Radio Corporation until May, 1929. At that time Mr. Sarnoff was in Europe with Mr. Young. I first met Mr. Schlesinger and considered the patents that he offered to the Radio Corporation some time later, I don't recall just when that was; and I did make a report to Mr. Sarnoff upon my later consideration of those patents.

1554 I was manager of the Patent Department of the Westinghouse Electric & Manufacturing Company until early in May, 1929, at which time I became director of Patent Development of the Radio Corporation of America.

Mr. Neave: Your Honor, while we are on this question of cross licenses in the testimony of Mr. Schairer, I would like to offer in evidence an agreement between the General Electric Company and American Telephone and Telegraph Company, of July 1, 1932, which is called the Substitute License Agreement and also is known as Agreement B-2. You will recall that there was the cross license be-

tween those two parties in 1920 and then there was a substitute license agreement between those two parties in 1926. That was known as Agreement B, or Modified Agreement B. This agreement of July, 1932, was a substitute for both of those prior agreements. The reason why I have offered it in evidence is because it shows the present situation of the parties as far as licenses are concerned; it shows that the licenses that were exclusive in the prior agreements have been changed; and more particularly it shows that the licenses are still granted for specified fields of use. That is, they are restricted licenses, restricted to licenses in certain fields.

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The way this contract of July 1, 1932, came about was that in 1930 the United States brought a suit in Delaware under the Sherman Anti-Trust Act against the Telephone Company, Western Electric and Products, and against Radio, General Electric and Westinghouse, and that suit was based upon complaints as to these 1920 and 1926 agreements that are already in evidence, and also other cross-license agreements between the various parties. Those agreements during the progress of the suit, which never came to trial, were renegotiated and changed so as to strike out the exclusive exchange of licenses. The July 1, 1932, agreement B-2 between the General Electric Company and Telephone Company was one of those that were so changed. Then in November, 1932, consent

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Case.

decrees were entered in that suit in Delaware. One of those decrees dismissed the Telephone and Western Electric Company from the case, and the decrees were entered upon a stipulation, entered into between the Government and the defendants, and in that stipulation the Government stated that it found no objections to these modified agreements, including this agreement B-2.

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I offer in evidence this agreement B-2 and I will ask if Mr. Darby will join me in a stipulation as to some of the facts recited.

Mr. Darby: I certainly object to the agreement. I do not see that it has any bearing whatever on the case—an agreement entered into in 1932.

Mr. Neave: The point is, your Honor, the Government has approved it.

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Mr. Darby: Only approved it for one possible consideration, with which this case has no concern.

Mr. Neave: They approved it, with licenses restricted to certain fields. That is my point.

Mr. Darby: Only as anti-trust laws are concerned. That is not involved in this suit.

Mr. Neave: That is a matter of argument.

Mr. Darby: No. I object to it as irrelevant and immaterial.

Mr. Neave: One of our points in this case is that restricted licenses of the character you have to deal with here are re-

garded as unobjectionable so far as restrictions of licenses are concerned—restrictions to fields. This is one item of evidence in that direction.

The Court: I think it may be admissible. I think questions of the weight to be attached to it are not at all simple. I think as an expression of the opinion of the Department of Justice in a Sherman Act case it may have some suggestive force. But it is perfectly obvious that if this Court disagreed with the views that the Department of Justice has recorded in that it would not hesitate very long to say so. You realize that?

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Mr. Darby: Yes, sir; but that is not the point. The point is that Mr. Neave is presenting an agreement which the Department of Justice has accepted, insofar as presumably—here is the logical conclusion—that there is nothing in that agreement that the Department of Justice objects to, for the same reason that it objected to the previous agreements—namely, there were exclusive patent rights among the parties.

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Mr. Neave is presenting it here in this case because of the fact that they included this restricted license feature which the Department of Justice was not in any sense concerned with in that litigation, and whether or not the Government approved it in 1932 in the anti-trust law case has no bearing whatever on what the situation was in 1929.

The Court: I am impressed a great deal by what you say.

1564

Case.

Mr. Darby: May I have an exception, your Honor, for the purpose of the record, and may I have a copy of the agreement?

The Court: Yes.

Mr. Neave: I offer in evidence the agreement marked "B-2, Substitute License Agreement, dated July 1, 1932, between General Electric Company and American Telephone and Telegraph Company.

(Marked Plaintiffs' Exhibit No. 40.)

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Mr. Neave: Mr. Darby, may we agree that in 1930 the United States brought a suit in the District of Delaware under the Sherman Anti-Trust Act, against the Telephone Company, Western Electric, Radio Corporation and subsidiaries, General Electric and Westinghouse, complaining principally that the cross license agreements then in existence between the parties, ~~susceptible~~ the 1920 and 1926 agreements, were unlawful?

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Mr. Darby: I agree to that, yes, so far.

Mr. Neave: That those agreements were after that suit was brought renegotiated and various other agreements were made between the parties, among which was the substitute license agreement that has just been marked Plaintiffs' Exhibit No. 40?

Mr. Darby: I accept your statement that they were renegotiated. I agree that this agreement of this date, Plaintiffs' Exhibit No. 40, was entered into at the time you state.

Mr. Neave: And will you also agree that in the stipulation upon which the consent decrees were entered in November of

1932 there is this provision: "The petitioner, by its Department of Justice, has examined all of the agreements attached hereto, also the abovementioned Substitute License Agreement (B 2) and agreements relating thereto, and finds no objection to them."

Mr. Darby: Might I read the entire stipulation?

Mr. Neave: Surely.

Mr. Darby: I will state to your Honor in connection with my objection that I was rather feeling in the statement I made to the Court because I was acting as Special Assistant to the Attorney-General in that case; and I am somewhat familiar with these stipulations. If your Honor please, I will admit that the stipulation was entered into, but I would like to have the entire stipulation in.

Mr. Neave: I offer in evidence the entire stipulation from which I read. I have no loose copy at the moment, but I will have one tomorrow morning.

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Mr. Darby: Your Honor, for the sake of the record might I make the same objection, however, to its admission, as to its relevancy and pertinency, as made in connection with the other offer?

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The Court: Same ruling.

(Marked Plaintiffs' Exhibit No. 41.)

Mr. Neave: Mr. Darby, you will also agree, will you, that in November, 1932, an order of dismissal was entered in that case in Delaware, dismissing the Telephone Company and the Western Electric

1570

Case.

Company from the suit, that order of dismissal reciting that the agreements that were complained of "have been modified so as to eliminate therefrom the provisions thereof which said petition asserted to be unlawful and by reason of which relief was sought against said two defendants"?

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Mr. Darby: Subject to my objection to the relevancy of the order of dismissal and subject to the request that the entire order go in, I have no other objection. Exception.

Mr. Neave: I will bring a copy of the entire order in the morning, with copies for Mr. Darby.

The Court: The date of the order is what?

Mr. Neave: November 21, 1932, and the stipulation was dated the same day.
(Marked Plaintiffs' Exhibit No. 42.)

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Mr. Darby: Exception.
Mr. Neave: Mr. Darby, will you agree that it is common practice where a patented invention is applicable to different uses, to grant written licenses under United States patents restricted to one or more of the several fields of use, permitting exclusive or non-exclusive use of the invention by the licensee in one field and excluding its use in another field?

Mr. Darby: I do not agree. As a matter of fact I believe that just the opposite or the contrary is true.

Mr. Neave: We will prove it.

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Direct.*

1573

FRANKLIN T. WOODWARD, called as a witness on behalf of the Plaintiffs in rebuttal, being duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is Franklin T. Woodward. I am assistant general patent attorney of the Western Electric Company, and general patent attorney of Electrical Research Products. I have been employed either by the Western Electric Company as a patent attorney or one of its subsidiaries since 1908.

1574

My department made an investigation in 1929 of talking picture amplifiers leased by the General Talking Pictures Company, the defendant in this case. The first investigation was on April 11th, 1929; the second and more detailed investigation was on April 19th, 1929. The investigation was made at the Strand Theatre in Allentown. A few days before April 11, 1929, I had been informed that there was a General Talking Pictures installation at that theatre. The investigation disclosed that there was an installation in that theatre. That was the first opportunity that we had been able to get to see a De Forest Fonofilm equipment.

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The reports which came to me shortly after the 11th of April with regard to the investigation of the 11th showed generally circuits but did not show them completely in the sense that they did not show the values of the various pieces of apparatus, such as resistances, capacities and so forth, and it was for that purpose

1576 *Franklin T. Woodward—For Plaintiffs—
Rebuttal—Direct.*

that the second investigation was made on the 19th.

After we had received the complete report we had made a careful engineering study of the various circuits shown in the reports. That was after the 19th; because it was not until the 19th that they had the measured values of the various elements. Made an engineering study to determine how these various circuits operated, and also patent study to see how they applied to the patents under which we were operating and under which one or more of the plaintiffs in this suit owned or had the right to sue. That was in itself a substantial job.

Our studies were complete early in the Summer of 1929, and my recollection is that bills of complaint were drawn up, at least tentatively, and we referred to Mr. Otterson for executive approval as to the bringing of suits in the latter part of July.

I am informed that Mr. Otterson went abroad
1578 on August 2, 1929.

We received an authorization to bring suit from Mr. Ling, who was then vice-president of the Products Company. Speaking for Mr. Otterson, he told us that he had been in telegraphic communication with Mr. Otterson, authorizing us to bring suits. That was on or about August 30, 1929. Then the suits were brought on September 13th, 1929.

Mr. Ashton: Mr. Darby, I will ask you to stipulate certain suits which I will mention, which were filed by the Western Electric Company and other plaintiffs

here, on these amplifier patents of the Telephone Company. The first suit was Western Electric, *et al.* vs. Biophone, in the District of New Jersey.

Mr. Darby: Just a minute, Mr. Ashton, before you proceed with that. May we have the Court rule on the relevancy of it? I object to it. I do not think it is material.

Mr. Ashton: The point, your Honor, is that we were not only bringing one suit against these defendants but bringing other suits at the same time, and it shows that these patents were being vigorously prosecuted. That is the point of the thing. They are matters of record and probably could be referred to, but I feel that their proper place is on the record here.

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Mr. Darby: I say it is irrelevant and immaterial, the fact of their bringing suits against anybody else.

The Court: It strikes me so, Mr. Ashton,

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Mr. Ashton: It is very pertinent, your Honor. The first suit which was brought, as so frequently happens, was brought a substantial time ahead of the present suit, and was of course a test case. That frequently happens. Sometimes defendants who are openly infringing are not sued for years.

The Court: I understand, but take your first case. Was an action brought for the infringement of these patents?

Mr. Ashton: Yes.

1582

Case.

The Court: Did that case go to an adjudication?

Mr. Ashton: The case that went to adjudication is the Wallerstein case. The Wallerstein case, the first bill of complaint in that case was filed on June 10, 1929.

Mr. Darby: That is already of record.

Mr. Ashton: There was one suit filed that I started to refer to a minute ago, some time earlier.

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The Court: You have not put a question now. You have asked Mr. Darby to stipulate.

Mr. Ashton: Yes.

The Court: As I understand it he says he is willing to stipulate if he is convinced that the evidence is relevant. Is that it?

Mr. Darby: That is it, your Honor.

The Court: Why not let Mr. Ashton finish his question directed to you, so that the question may contain the necessary dates and titles, before you answer him?

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Mr. Darby: All right, your Honor.

The Court: Have you a date on the Biophone case?

Mr. Ashton: No, we have not. Continuing from where my question or statement left off, the Biophone bills were filed June 11, 1929. Still an earlier suit was Western Electric, et al. vs. Stanley Company of America, filed in the District of Delaware on May 16, 1929. A consent decree was entered in this suit on December 11, 1933, as to the Lowenstein patent.

Mr. Darby: What happened to the remainder of them?

Mr. Ashton: The bill of complaint was dismissed without prejudice as to three of the patents, and as to the patents passed upon by the Court of Appeals here in the Wallerstein case it was dismissed with prejudice. The earliest suit of all was the suit of Western Electric, *et al.*, vs. Pacent Reproducer Corporation, *et al.*, filed in the Southern District of New York on March 30, 1929. A second suit was filed against this same company due to a ruling that there was a misjoinder of parties plaintiff in the original suit. This second suit was filed on June 7, 1929. In that suit a decree was entered on October 22, 1932, providing for an injunction and an accounting on the Lowenstein patent.

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Mr. Darby: Was that by consent?

Mr. Ashton: That was a consent decree.

Mr. Darby: And what happened to the remaining patents in the suit?

Mr. Ashton: They were dismissed without prejudice. The case of Western Electric vs. Wallerstein was filed on June 10, 1929, in the Western District of New York at Buffalo. That is the case in which the opinion of the Court of Appeals has been presented to your Honor.

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The Court: That is not Judge Winslow's case?

Mr. Ashton: No, the Wallerstein case was decided by the Court of Appeals of the Second Circuit, originally tried by Judge Galston, who was assigned to go to Buffalo in January.

1588

Case.

Mr. Darby: Judge Winslow's case was a radio case, your Honor.

Mr. Ashton: The original Wallerstein bill of complaint was filed on April 20, 1929, in Buffalo, and that was dismissed for misjoinder of parties plaintiff for the same situation as was involved in the Pacent case.

Mr. Darby: Does that complete it?

Mr. Ashton: Yes.

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Mr. Darby: Will you complete your statement before I make my objection to the entire thing, and tell us what happened to the first suit that you mentioned, the Biophone, or something like that?

Mr. Ashton: The Biophone.

Mr. Darby: Is that it?

Mr. Ashton: Yes.

Mr. Darby: You did not tell us what happened in that case.

Mr. Ashton: That case is still pending.

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Mr. Darby: It has never been tried!

Mr. Ashton: Never been tried.

Mr. Darby: I accept Mr. Ashton's statement as to the facts. I object to the admissibility of the statement, as irrelevant and immaterial.

The Court: In other words, you answer his question in the affirmative, but without prejudice to your right to urge that that situation does not have any bearing on this case?

Mr. Darby: That is right, your Honor.

The Court: That will avoid an objection.

Mr. Darby: Mr. Ashton, in connection with that statement is it not a fact that none of those cases involved a situation presented by the defendant employing apparatus acquired by a licensee of the R. C. A., as an issue before the Court?

Mr. Ashton: I have already told you that the question of vacuum tube license was involved in the Wallerstein case and was not even mentioned in the decision, and the petition for rehearing specifically on that point denied.

The Court: That may be informative, but it does not strike me that it is. He asked you a plain simple question, and I do not think you have answered it. He says, is the issue raised in any case of a defendant having purchased an amplifier from a licensee? Isn't that the question?

Mr. Darby: That is the question, your Honor.

The Court: I do not think your answer 1593 is responsive.

Mr. Ashton: I am sorry, your Honor. I accept your understanding or recollection of the question, but I did not understand Mr. Darby to mean it as narrow as that. If he means by his question the question of purchase of a complete amplifier alone, there has been no case, that is true. But the question of tubes has been raised. Of course there has been no case involving these arguments or estoppel, either.

The Court: Yes, but we are confronted

1594 Franklin T. Woodward—For Plaintiffs—
Rebuttal—Direct.

here with the acquisition of a complete amplifier.

Mr. Ashton: That is true.

The Court: From a licensee. The amplifier not containing the tubes, the tubes having been purchased by the defendant in the open market.

Mr. Ashton: Very true, your Honor.

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The Court: That precise question, as I understand it, has not been presented in any of the cases to which you have referred in your stipulation?

Mr. Ashton: No, not precisely. As a matter of law I think it unquestionably has been.

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Q. Do you know whether it has been common practice for any substantial period of time, where a patented invention is applicable to different uses, to grant written licenses under United States Letters Patent, restricted to one or more of the several fields of use, permitting the exclusive or non-exclusive use of the invention by the licensee in one field and excluding its use in another field?

Mr. Darby: I object to the question as irrelevant and immaterial, and, what is perhaps more fundamental, the incompetency.

The Court: That is quite an important matter, isn't it?

Mr. Ashton: It is very important, your Honor. To give you a little background on it if you would care to hear it, the pre-

cise stipulation which Mr. Neave read to Mr. Darby is the one which was stipulated in this case which I told you about in the opening statement, the so-called Independent Case that was settled. And then Mr. Davis made the same stipulation in the Wallerstein case, and it was on a stipulation such as that that case went to the Court of Appeals.

Mr. Darby: No, the case never went to the Court of Appeals.

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The Court: I apprehend that Mr. Darby is going to point out that the practice necessarily has been influenced by the decisions of the United States Supreme Court and an abstraction such as you propounded to the witness calls upon him to make only an argumentative response.

Mr. Ashton: I do not think that is true, your Honor. I am asking him whether he knows that it has been such a practice. If Mr. Darby objects to his qualifications, as to why he would know if there was any such practice, I would be very glad to go into that. But I am merely asking him whether he knows that it has been common practice.

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The Court: Perhaps I was pretty rude in not giving Mr. Darby an opportunity to state what his objection was. I think I should have.

Mr. Darby: I think your Honor has correctly stated it. Moreover, I do not see how it is possible for Mr. Neave to produce a man who has been a certain number of years with the Western Electric Com-

1600

Case.

pany in the Patent Department, to give testimony, of any competency whatever, on the question what is common practice. He can certainly state what is common practice with the Western Electric Company, if it is relevant. Mr. Ashton called me up and told me that Mr. W. H. Davis had entered into such a stipulation in the Independent Wireless Case, and asked me if I would do the same thing. I told him I could not conscientiously, because not only could I not agree that that was the common practice, but I know I thoroughly disagree with whether it was or not. In other words, I was confident that was not the common practice. In my own case, I know I would not allow my own clients to do it, because I did not think it was legal.

1601

The Court: It is a kind of technical situation here, Mr. Ashton, and I would like to get into the record as matter for the reviewing court whatever testimony would be relevant on the question of the practice known to this witness. I am wondering if you could reframe your question so as to ask him what the practice to his knowledge, on the part of the Western Electric Company, has been within a certain period of time.

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Mr. Ashton: I can do that. His experience, your Honor, is wider than merely what the Western Electric Company and these other companies have done as far as contracts which have originated with them. It extends also to contracts with other and independent inventors.

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Direct.*

1603

The Court: When was Bauer vs. O'Donnell decided?

Mr. Ashton: I cannot tell you, your Honor, without perhaps getting the book.

The Court: It was about fifteen years ago, wasn't it?

Mr. Darby: Yes, your Honor, perhaps a little bit longer than that. About 1923.

The Court: That is only eleven years ago. That certainly must have influenced 1604 the practice, must it not?

Mr. Ashton: Not as to these things at all, your Honor, because those have never—

Mr. Darby: It was 1912, your Honor.

Mr. Ashton (Continuing): —been taken up by the Patent Bar. You were suggesting, your Honor, that it be confined to some period of years that I had not in mind, to make it definite, but I have no objection to doing so.

The Court: I think you had better make it definite as to a period of years and either restrict it to the Western Electric Company or else lay a broader foundation.

By Mr. Ashton:

As to what experience I have had since my employment as a patent attorney by the Western Electric Company, with patent license contracts, I have had some experience along that line ever since I have been with the company, but more particularly since 1924. One of my regular duties is to consider the advisability of and negotiate licenses under the patents of others as well as

1606 Franklin T. Woodward—For Plaintiffs—
Rebuttal—Direct.

prepare and or approve contracts for licensing under our patents.

Q. What do you know about the practice of entering into restricted license agreements by the patentees and by companies owning patents?

A. It is the common practice for—

Mr. Darby: I make the same objection, if your Honor please.

1607

The Court: It is not necessarily conclusive on you. You can produce your witness who will testify that he followed your practice—or I mean the practice that you believe prevails.

Mr. Darby: I am willing to stipulate, if it will be of any assistance to Mr. Ashton, that it is, if he tells me it is, the common practice of the Western Electric Company and the Radio Corporation to do that.

Mr. Ashton: It is broader than that—much broader than that.

1608

Mr. Darby: I do not believe you have established the competency of this witness to testify about it.

Mr. Ashton: As to that I will ask another question.

Mr. Darby: I am at your last question now, which is based on one qualifying question, which I submit does not qualify the witness to answer.

Mr. Ashton: I will ask a further question on qualifications.

By Mr. Ashton:

During this period in which I have had to do with contracts, I have received contracts from

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

1609

patentees having no connection with the Western Electric or associated companies, as well as from companies owning patents, to pass upon.

Mr. Darby: May I test the qualifications of the witness before he testifies on the subject?

The Court: Yes, I think you are entitled to that.

1610

Preliminary Cross Examination by Mr. Darby:

As to whether all these contracts have been in connection with negotiations with the Western Electric Company either to grant licenses under Western Electric or associated companies' patents or acquire licenses for the Western Electric and associated companies under patents owned by others, the first part I had assumed. My answer was directed to the second part—that is, those who had offered us, came to us asking us to acquire licenses, and the form of contracts they submitted to us. Yes, all having to do with your work with the Western Electric Company.

1611

Mr. Darby: I renew my objection.

Mr. Ashton: I think he has qualified now, your Honor, surely.

The Court: Yes, I will take it. Objection overruled, with exception.

By Mr. Ashton:

Q. Do you know of any contract upon which the defendant in this case has relied which is

1612 Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.

a restricted license contract? A. Do you mean under which we have taken a license?

Q. No, under which your company has claimed a license?

Mr. Darby: I certainly object to that. If there is any contract in this case on which we are relying, it speaks for itself.

1613

Mr. Ashton: Mr. Darby, the contract which I am referring to is the contract that you relied upon in the Stanley case in Delaware, and in which you insisted on behalf of this very defendant upon very definite restrictions in the contract itself, namely, the Western Electric agreement, that Dr. De Forest entered into with the Western Electric Company.

Mr. Darby: Is that contract in evidence in this case?

1614

Mr. Ashton: It is going to be offered.

Mr. Darby: You mean it is not in evidence at the present time?

Mr. Ashton: It is going to be offered in a moment.

The Witness: The contract handed me, between the De Forest Company of Delaware and American Telephone and Telegraph Company, I believe—I am looking for the parties here—and the Western Electric Company, Inc., was negotiated while I was in Europe, but I have frequently had occasion to consider it since my return. I considered it in connection with the litigation which was just referred to, brought by this defendant against the plaintiff.

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

1615

Q. And did the defendant in this case rely upon the restrictions in the contract?

Mr. Darby: I object to that, if your Honor please.

Mr. Ashton: It seems to me, your Honor, that that is directly in point. Mr. Darby is going very far in his statement as to the policy of his clients and so on, in entering into these agreements, and it seems to me it is very pertinent that he has stressed these restrictive provisions in this contract in a talking motion picture litigation in Delaware, brought against the same plaintiff.

1616

The Court: That brings us back to where we were last Thursday morning, I think. I asked you how long it had been the rule that lawyers had to be consistent, and the rule has not changed since then.

1617

Mr. Ashton: I did not mean to suggest that he should be consistent, but I think it has a bearing on our proofs.

The Court: You see how leading the form of your question is. The contract relied on by the defendant in this case, as I understand it, is the license between the plaintiffs in this case and the American Transformer Company. It has nothing to do with something that was brought into another litigation.

Mr. Ashton: I understand, your Honor. This bears on the common practice to enter into these agreements and that is all I am trying to—

1618 *Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

The Court: Why not ask this witness whether he knows that this defendant company, the General Talking Pictures Corporation, ever entered into a restricted license agreement with anybody else?

The Witness: I do not know that.

Q. Do you know whether the General Talking Pictures Company has relied upon such an agreement?
1619

Mr. Darby: I object to that, if your Honor please.

The Court: I will sustain the objection, with exception.

Q. Will you refer to other licenses restricted to particular fields of use or purposes which have come to your attention (handing witness papers)?

1620 Mr. Darby: I object to this, if your Honor please.

The Court: Do you want him to state a number, or do you want him to state facts with reference to each?

Mr. Ashton: I want him to point out a few of the agreements, your Honor, to show that it was common practice to have such agreements. That is exactly what I want, and I want him to point out the fields of use, which these agreements have been limited to and mention a few of them as briefly as possible.

The Court: Is he going to present con-

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

1621

tracts that were offered to him by persons desiring to enter into contractual relations with the Western Electric Company!

Mr. Ashton: I think it is largely that. There are several other agreements that have come to his attention in connection with his usual work, which I also had in mind to ask him to refer to, including this one that we just had a moment ago.

1622

The Court: Cover it as briefly as you can in justice to your case, Mr. Ashton.

Mr. Ashton: I am perfectly willing to offer the contracts in evidence themselves and let them speak for themselves. I do not think it is necessary to have the witness refer to each one in detail. I will therefore do that when I offer my exhibits.

1623

The Court: Would your purpose be served by waiting to see what Mr. Darby develops in cross examination on this subject? The witness has made a statement as to what he knows the practice to be, and he states that in a large number of instances such contracts have been presented to him and have been entered into by the Western Electric Company with persons presenting them. Isn't that *prima facie* all the proof you need?

Mr. Ashton: I will turn the witness over at this time, your Honor.

Cross Examination by Mr. Darby:

It is correct that the Telephone Company is interested—and by the Telephone Company I

1624. *Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

mean the Telephone Company and Western Electric Company, just those two for the moment—are interested only in certain lines of work, namely, the transmission of intelligence, transmission and reception of intelligence—communications, in other words, is correct.

1625 It is the standard policy of the Telephone Company when inventions are submitted to them to be sure that they get rights in that particular field. I would assume it is frequently to my knowledge and in my experience immaterial to the Telephone Company if it gets rights in additional fields, as long as those particular fields in which we are interested are protected.

In purchasing patent rights from different people it is a general practice with the Western Electric Company and the Telephone Company to purchase only rights in the particular fields in which it is interested, although I have known of instances where they would have acquired further rights if they could have.

1626 In some instances rights in their particular field were all that were offered them. May I qualify that? Not only that, but sometimes even less than their particular field—even less than the whole of their particular field. I have in mind the negotiations with the General Electric when I make that statement.

As to whether it is not a fact that in the acquisition of rights under the De Forest patents, the audion, the 3-electrode audion patent, the original audion patent, that we were able to acquire rights for our particular field for less than was asked for the use of the audion in other fields, I was not in on those negotiations, but I

*Franklin T. Woodward—For Plaintiffs—
Rebuttal—Cross.*

1627

recall that they covered three or four separate negotiations eventuating in separate documents, and I assume that is a fact. I am familiar with those agreements.

Broadly stated it is true that the patent policy of our company, to protect ourselves against attack rather than to acquire patent rights with which to attack others. We do not want to pay for anything which we do not need, and we do not want to buy litigation. And for that reason, so far as the commercial operations of our company are concerned, all that we are primarily interested in is to acquire rights under any patents which we think might interfere with our continued operation.

1628

Mr. Darby: That is all I have to ask the witness on that subject, your Honor, unless there is any phase of it that occurs to your Honor. I have further cross examination of the witness, however.

The Court: Then go on with it.

1629

In connection with these circuits that were sent to me in April, 1929, showing what the General Talking Pictures equipment consisted of, sketches and written reports were sent to me. The report stated who was the manufacturer of the apparatus. I remember that very distinctly. One amplifier had the manufacturer's label on it, yes. The vacuum tubes were not sent to me with the report. I don't recall for sure whether any measurements were given for the internal impedance of the vacuum tubes in the report, but I know that they made on the second test, the

1630 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

second inspection—they made such measurements as the engineers deemed necessary to know exactly how it worked. I am very sure the report gave the characteristic type numbers of the vacuum tubes. I don't recall whether the report included any measurements of internal resistance or impedance in the tube.

Re-direct Examination by Mr. Ashton:

1631 The first that I knew that the General Talking Pictures Corporation had made an installation of an American Transformer Company amplifier was in the early report of the inspection of April 11th, 1929.

FRANK N. WATERMAN, resumed the stand.

Direct Examination Continued by Mr. Ashton:

1632

Q. Will you continue with the references against the Straight Line Characteristic Patent? You had not completed the Colpitts patent 1,137,384. I believe you had one more thing that you wished to state as to that. A. So far as I recall I was stating at the end of the answer last given the necessity for adjustment of the generated frequencies and the modulation intensity with respect to one another. Correcting that statement, the adjustment of frequency and intensity of oscillation, and the adjustment of the intensity of modulation, in order that the carrier wave might properly represent the signal. That is the

Frank N. Waterman—For Plaintiffs—Recalled 1633
Rebuttal—Direct.

reason for the large number of adjustable elements, and it is one of my reasons for believing that the element referred to by Mr. Cloud is an inductance and not a resistance.

Q. Kendall patent No. 1,330,471, Tab No. 20. A. As I recall the matter, Mr. Cloud referred to the resistance 80 in the middle stage of Fig. 4 as being a plate circuit resistance. I call your Honor's attention to the fact that the resistance 80 is a parallel feed. It carries the current from the battery to the plate 33, while the alternating current path is through the condenser 81, the primary coil 82, thence back to the filament. Thus the alternating current path is different from the direct current path, and the sole effect of the resistance 80 in a parallel path is to decrease and not to increase the total output resistance, since two paths are easier than one. It make no difference what the resistance of 80 is, it decreases the total plate circuit resistance. Therefore, it is not a resistance added to an existing circuit. The filament current is from a little battery, not numbered, just above the battery 35, and the filament circuit is a circuit purely local to that battery. The filament is a part of the plate circuit and the conductor on one pole of that small filament battery runs down to the negative pole of the battery 35.

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1635

By the Court:

Q. That is assumed to be the negative pole, isn't it? A. It is known to be, because the tube only works with the negative pole of the B battery connected with the filament. Therefore

1636 *Frank N. Waterman—For Plaintiffs—Recalled—Rebuttal—Direct.*

the direct current flow is from the right hand pole of the battery 35 up through the resistance 80, then to the left, to the plate 32, thence across the space to the filament 30, and back to the battery.

Q. To the battery 31? A. The battery 35. It travels, part of it, actually through the battery 31. We ordinarily disregard that.

Q. It is not 31; it is an unnumbered battery.

1637 A. Unnumbered battery, adjacent to '31.

Mr. Ashton: 31 is the grid.

The Court: 31 is the grid, yes.

The Witness: The alternating circuit is from the plate 32 of the tube to the right through the condenser 81, then down through the primary 82, then to the left, back to the filament, the alternating current therefore circulating through the tube and the circuit that I have traced. It follows that insofar as alternating current gets into the resistance 80 it would start from the plate down through the resistance 80, then through the battery 35, back to the filament; but that resistance merely furnishes an additional path. Therefore it reduces the total resistance that the total alternating current has to encounter, and it makes no difference what the resistance of 80 is, it reduces the resistance of the alternating current path. If 80 is very large, then but little current will flow that way, and it will reduce the resistance only a little; whereas if it is smaller, then it will reduce the resistance still more.

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1639

By Mr. Ashton:

Q. Would not a modulating tube fail to modulate if it had a straight line output characteristic? A. Yes, it would, because the modulation is dependent upon the lack of symmetry in the reproduction, or as it is ordinarily stated, upon the distorting properties of the tube.

Q. That is, a curved characteristic rather than a straight one is required for a modulator, is it not? A. That is correct; just the same as for a detector.

1640

Q. And it is necessary to deform the outgoing current in order to impose the voice upon it?

A. Yes.

Q. If the unidentified resistance in this patent— A. Which one are you talking about?

1641

Q. The same, the Kendall patent. I would like to know if the resistance in the Kendall patent 80 were relatively small, whether it could have any effect in the output circuit? A. Well, I assume that by "relatively" you mean relatively to the circuit, through the condenser 81 and 82.

Q. Yes. A. It would rob the output circuit to that extent and would limit the output of the tube.

Q. Only in the event that it was relatively small could it have any effect in the output circuit; is that right? A. That is true. Such resistance would be made of such value that it could be disregarded in the operation of the tube.

Q. And it is a parallel feed resistance, is it not? A. It is a parallel feed resistance entirely.

1642 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

Q. And is a parallel feed resistance always made large? A. Yes.

Q. Why? A. In order that any effect which it has in carrying alternating current may be very small as compared to the current carried in the intended alternating path.

Q. Is the resistance 80 in the A-C output circuit? A. It is not.

1643 Q. And the tube 33 is functioning as a detector? A. Yes.

Q. Will you refer to De Forest patent 1,375,447, which is tab No. 24. In Fig. 1 of this patent the element 13 is a reactance, is it not, serving as a coupler whose value is not in any way indicated? A. That is true.

Q. Is the same also true of Fig. 2? A. Fig. 2 is a two-coil transformer, whereas 13 in Fig. 1 is a single coil or auto-transformer.

1644 Q. What have you to say about the loud speakers in Fig. 5? A. The loud speakers are each operated by its own amplifier, and these amplifiers are connected to the secondaries of transformers whose primaries are connected in series in the output circuit of the tube 26. No description of any of the elements is given so that one knows nothing about what the transformers are, but the tubes or their grid circuit impedances may be. It is therefore wholly a matter of speculation as to what the nature of the output circuit of the tube 26 may be.

Q. Were the loud speakers available at the time of the application of this patent, namely 1913, any more than merely telephones supplied with horns? A. So far as I knew them, that is all they were.

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

1645

Q. Did ordinary commercial telephones have a low resistance and impedance? A. Yes.

Q. Can you compare the impedance of three such telephones with the impedance, for example, of one De Forest tube? A. It would be a very very small fraction. The De Forest tubes were very variable. Of course we did not in those days know anything about alternating current impedance of the tube. Since that subject has been understood, some of them have been re-pumped and tested, because it was practically impossible, as to most of those tubes, which had so much gas in them, to determine any definite alternating current resistance that would stay put, even if we had known how.

1646

But from such results as I have had from use, and seen published, the plate circuit impedances of those tubes ran—I have not the exact figures in mind, but say from 50,000 to 250,000 ohms, whereas the telephones would have been at most of the order of 2,000 or 3,000 ohms, and probably much lower.

1647

Q. Does the patent make any disclosure as to the impedance of either the loud speakers or of the tubes? A. It does not.

Mr. Ashton: I have called Mr. Darby's attention to the fact that in a number of instances the prior patents relied on were applied for before the application dates of the patents in suit, but were issued later, and Mr. Darby has not proved what the applications contained as they were originally filed. I want to make it very clear to him so that he can have an opportunity

**1648 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.**

to do that, or some arrangement can be made whereby he will advise me of any differences.

Mr. Darby: I am perfectly willing to do it in the most expeditious manner. My understanding of the law in this Circuit is that when a patent is issued it is presumed to have issued on the application as filed, as appears on its face, unless something to the contrary is established.

Mr. Ashton: Will you undertake to furnish me the applications as filed, of any patents that you relied upon?

Mr. Darby: No, sir, I will not.

JOHN E. OTTERSON, recalled.

Mr. Darby: Mr. Zelony, will you step down here, please?

(The witness Zelony steps forward.)

1650 By Mr. Darby:

I do not recognize this young man. I do not recall that I have ever seen him before, except in this courtroom. I am quite positive of that.

FRANK N. WATERMAN, resumed the stand.

Direct Examination Continued by Mr. Ashton:

Q. We were on the Arnold patent 1,349,252, the Straight Line Characteristic Patent, and the next patent to be taken up is Weagant No. 1,384,108. This patent goes, does it not, to a

Frank N. Waterman—For Plaintiffs—Recalled— 1651
Rebuttal—Direct.

transmitter generating oscillations by what is known as gas interruption? A. It does.

Q. In other words, it is dependent upon the gas content of the tube for its operation, but was not intended for telephone signals? A. That is correct. It depends upon the gas operation and a critical adjustment of the voltages to the tube.

Q. Is the tube shown at 13 for adjustment purposes merely? A. The phone, you mean. Yes, the telephone shown at 13 is in order that the adjuster may determine when the tube is operating properly for transmission purposes. 1652

Q. Does this appear from page 1, line 81, of the specification? A. It does.

Q. Is the signal sent by the key 11? A. It is.

Q. Is the resistance 15 shunted by a condenser 16 which carries the variable current? A. Yes, the variable current passes through the condenser 16. The resistance 15 serves only to carry the direct current and to determine with precision the voltage applied to the plate 9. 1653

Q. Does the resistance 15 have any substantial effect of increasing the A-C impedance of the output circuit? A. It does not.

Q. Is it stated at page 1, line 90, that the resistance 15 is not necessary to the operation of the device? A. It is so stated.

Q. Now, will you take up the Hewitt patent, 1,393,369? Does Fig. 1 disclose a mercury arc? A. It discloses a mercury arc of a peculiar type, similar to that considered in the Pierce patent, with the exception that the control member 8 is coated with glass or other insulating material.

1654 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

so as to be entirely insulated from the ion stream.

Q. And does Fig. 2 show a corresponding arrangement? A. It does, except that the tube is of the hot filament type instead of the arc type. The grid is similarly protected from conductive connection to the ion stream by enclosing it in glass or other insulating material.

Q. What is the purpose of the resistance 10?
1655 A. The resistance 10 is a ballast resistance for stabilizing the arc in the lower portion of its operating range before it passes into the negative resistance state.

Q. Were the uses of resistances and inductances common in mercury arc devices for the purposes of stabilization? A. They were. You can see that illustrated also at 5, 6, in the same figure, the arc being stabilized by inductance 6 and resistance 5. The arc of the anode 2 is stabilized by the resistance 10, and its own translating device.

1656 Q. And do the resistances 19 and 20 in Fig. 2 have the same purpose? A. They do.

Q. What does the patentee mean when he states at page 2, that the filament acts as a negative to receive positive current? A. It means that it acts as a cathode in the same sense that the mercury pool does in Fig. 1.

Q. What does that have to do with ionization or gas conduction? A. He merely applies the same terminology and the same reasoning throughout to the two devices, contemplating the same action, namely, ionized gas action.

Q. Does the inductance 9 and also the resistance 20 act to stabilize the current, and are they

Frank N. Waterman—For Plaintiffs—Recalled 1657
Rebuttal—Direct.

necessary for that purpose? A. Yes, otherwise the blue haze would become self-perpetuating, and the devices would become inoperative. They are necessary to keep them in the critical state that they are desired, to operate as desired.

Q. Does the fact that the grid 16 is enclosed in glass indicate anything as to the type of tube? A. Yes, it indicates that the positive ionization is the phenomenon which he is using, and he desires to use the electrostatic field only which can pass through the glass with perfect readiness and does not desire to have the grid enter into any conductive relation that would disturb the arc.

Q. Now, we take up Arnold Patent No. 1,403,475, tab D, resistance capacity coupling patent and refer first to Arnold Patent 1,129,942, tab 10; do you agree with Mr. Cloud that the difference between resistance and inductance is an essential difference in this case? A. I do most emphatically.

Q. Have you any further comment to make on this Arnold Patent 1,129,942? A. Not unless you want the reason explained. The reason is that the inductance is not independent of frequency. The purpose of resistance capacity coupling is to get an arrangement which is independent of frequency components of the alternating signal current.

Q. We now take up the Nichols Patent 1,257,381, tab 18, and I just want to point out in connection with this patent that it is antedated according to plaintiffs' position, and that it does have a resistance battery coupling. Will you now comment on that, please, Mr. Waterman? A. It

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1660 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

has resistance battery coupling 15, as shown in the various figures, the purpose being to modulate the oscillator tube 17, in which case the tube 17 is an oscillator. The general scheme is to receive the very low frequency impulse on the cable, pass it on through a coupling tube to a high frequency oscillator 17, then detect, that is, get rid of the way it is put in and pass it on the outgoing cable. The object of the whole complicated arrangement is to avoid the necessity of transformers, at the same time to make possible the duplex operation of the cable.

1661

Q. Will you refer now to Arnold Patent 1,398,665, tab 29; does it show any coupling between tubes? A. No, it does not. This merely relates to the high potential tube.

Q. Does it show a parallel feed with a reactance coil 8 for the output circuit of the tube? A. Yes.

1662

Q. Now, will you please take up Arnold Patent in suit, 1,448,550, the Input Impedance Patent, and I point out to your Honor that it is the plaintiffs' position that all the patents relied upon as to this patent have been antedated. Do you have any further comment to make on the patent itself, Mr. Waterman? A. I don't remember that I have.

Q. I thought you told me you had. We will pass then to the next patent, Arnold Patent No. 1,465,332, tab G, The Common Supply Plant. Will you refer to Arnold Patent 1,129,942, tab 10. In this Arnold Patent 1,129,942, is it material whether or not power is supplied from a common battery or from separate batteries? A. No, not the least.

Frank N. Waterman—For Plaintiffs—Recalled 1663
Rebuttal—Direct.

Q. Will you refer to the claims of the Arnold patent in suit, 1,465,332 in connection with the Arnold Patent 1,129,942, particularly claims 1 and 5 and point out whether or not you find the subject matter of those claims disclosed in Arnold Patent 1,129,942?

Mr. Darby: Oh, I object to that question, if your Honor please, I think that is assuming the authority of the Court.

The Court: That is the customary objection and it is customarily overruled. You may have an exception.

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Q. Do those claims call for series inductances as well as bridging capacity? A. They do.

Q. Is there any such inductance shown in Arnold Patent 1,129,942 as a filter means to prevent the oscillation in the system? A. There is not.

Q. Have you any further comment to make on those two claims? A. No.

Q. Now, will you refer to claim 8 for the moment, Fig. 6 of this Arnold Patent 1,129,942 just referred to, and also in Mr. Cloud's testimony, Defendant's Exhibit I; there are three tubes there, are there not? A. Yes.

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Q. Does the claim 8 read upon that feature, there being three tubes? A. No, it does not.

Mr. Darby: I make the same objection, your Honor.

The Court: The same ruling and exception.

Q. This Arnold patent shows three tubes, does it not, with only two of the plate circuits bridged? A. That is correct.

1666 *Frank N. Waterman—For Plaintiffs—Recalled—Rebuttal—Direct.*

Q. Claim 8 calls for bridging of all three, does it? A. It calls for bridging each of the circuits.

Mr. Ashton: I point out to your Honor that the patent referred to above was 1,129,942.

1667 Q. Refer now to Campbell Patent 1,227,118 and state whether or not the disclosure of this Campbell patent has any bearing upon the invention of the patent 1,465,332, in your opinion? A. I am unable to see that it has the slightest bearing. Of course, it sets forth a very notable invention, a landmark in the art, but that has relation to the matter of the passing of signals of certain ranges of frequencies in the line and cable transmission. I am unable to see that it has any bearing upon the particular combinations which are dealt with in the Arnold Patent 1,465,332. There is nothing to compare, because there is no resemblance.

1668 Q. Now, Alexanderson Patent 1,340,101, tab 21; are the tubes shown in this Alexanderson patent three-element tubes? A. No, they are four-element tubes, known as grid rectifiers. The purpose is to absorb part of the energy of generator 1. That is a part which is proportional to the signal transmitted through the microphone 18. It is what might be called a "robber circuit"; it robs the generator 1 and allows what it does not take to go out on the air.

Q. Are they amplifier tubes in any ordinary sense? A. No, they are not. I do not know that they are in any sense whatever.

Q. How would you refer to them, as variable

Frank N. Waterman—For Plaintiffs—Recalled 1669
Rebuttal—Direct.

impedance tubes? A. They are variable impedances, energy absorbers in the nature of rectifiers.

Q. Is the plate supplied by battery 16 and not by generator 1, as Mr. Cloud testified? A. Well, it would be correct to put it both ways.

Q. It would? A. Whatever direct current bias is placed on the plates comes from the battery. The main purpose of the battery, however, is to provide progressively different negative biases on the several tubes, so that they come into action progressively according to the intensity of the signal. The idea is that a small signal such as microphone 18 might give would be able to modulate the output of the large generator of thousands of units of power; they are therefore governed in that peculiar way. They do act as energy absorbers.

Q. Is the aim to modulate the current from generator 1, which is the plate to antenna 2 and 3? A. Yes.

Q. Is the voltage from the microphone 18 imparted to the transformer 15 to the grids of the tubes in parallel? A. Yes. They come into the plate successively, and they are always in parallel.

Q. Does the cascade operation exist in the disclosure of this patent? A. Oh, no, not at all; not at all. They are purely energy absorbers.

Q. Do currents successively amplified flow through the battery? A. No.

Q. Now, take up Arnold Patent 1,520,994, the Gain Control Patent, tab H. It is defendant's position that the invention of this patent constitutes double-patenting of the Arnold Patent

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1672 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.*

1,448,550; will you compare the inventions, please? A. The patent 1,448,550 goes to the question of what the lines, the incoming signal circuit see as they come into the tubes. The arrangement being organized wholly from that point of view. The resistance 6 shown across the secondary of the input transformer in the drawing is shown as a fixed definite resistance, and so described.

1673 It is selected for the several purposes as I have explained in my earlier answers in my *prima facie* deposition. The tube receives the entire voltage drop across resistance 6.

In Patent 1,520,994 the purpose is to control amplification without affecting either the selected circuit conditions or the tube operation. Many methods of volume amplification control have been attempted. The trouble with most of them is that they affect the quality. The arrangement shown in Arnold Patent 1,520,994 gives complete control of the amplification without in any way

1674 affecting the performance either of the tubes or of the circuits. Physically and diagrammatically it differs only in that it has the sliding contact 26 which can take off any part of the alternating current voltage developed in the resistance 25 and applied to the grid. Actually the circuits may be designed from the point of view of volume control so that actually the resistance 25 is not necessarily the same resistance that would be used for the purpose of 1,448,550, although diagrammatically they are the same, and they might be the same actually. The patent 1,448,550 in no way suggests the possibility of the amplifica-

Frank, N. Waterman—For Plaintiffs—Recalled— 1675
Rebuttal—Direct.

tion control feature, which is the disclosure as I understand it, of patent 1,520,994.

Q. You were present and heard Mr. Kendall's testimony, did you not, regarding an attempt to make adjustments by adjusting the B battery?

A. Yes.

Q. I would like to ask you if the result of doing that would be this—namely, varying the output impedance of the tube and changing the amplifying efficiency of the set-up? A. Yes. All of the methods which vary the other batteries have serious effects on the operating characteristics of the tube and the relation of the tube to the circuit. The method disclosed in 1,520,994 as far as I know is the only one developed up to date which does not affect the performance either of the circuits or of the tubes.

Q. That is, you can make an adjustment without changing the constants which you have prepared in advance for the circuit? A. That is correct.

Q. I would like you to refer back a moment to that Alexanderson patent No. 1,340,101, in connection with the preceding patent 1,465,332, tab 21, and I ask you if the purposes of the resistances 11 are not by-passes for alternating current by condensers 20, so that the resistances do not affect the alternating current characteristic of the rectifiers? A. That is correct.

Q. I mean beyond limiting the rectifying current the tubes can handle? A. The resistances 11 cooperate with the variable resistance of the tubes to act as energy absorbers. The alternating current is by-passed in the condenser 20. In other words, there is a rectified current there,

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**1678 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.**

and where there is a non-rectified current the resistance will absorb energy from the rectified current. The alternating current is by-passed by the condenser.

Q. That prevents the tubes from destroying themselves, does it? A. Yes. That is explained in the specification.

1679 Q. Now the patents relied upon with respect to the patent 1,520,994. Refer to the Von Lieben patent 1,038,910, tab No. 6, mentioned by Mr. Cloud, and state if this patent contains any disclosure pertinent to the Arnold patent in suit just referred to? A. The Von Lieben patent shows no amplification control at all. I believe that Mr. Cloud referred to the potentiometer c in Fig. 2. That of course is a potentiometer. It is placed across the filament, and the slider takes bias for the filament to the sieve member H, but it has no relation to the varying of the signal voltage applied to the grid, which is the essence of the Arnold arrangement in 1,520,994. I may say that the potentiometer *per se* is a very very old device. It is one of the oldest of electrical tools, and is used for many different purposes, so that I do not understand that there is anything novel in the potentiometer. It is the use that Arnold made of the potentiometer, which avoided the difficulties of distortion previously existing in attempts to vary amplification. That is the particular feature of the patent as I understand it.

1680 By the Court:

Q. That is, he used an old device to accomplish a new purpose; is that it? A. That is my understanding.

Frank N. Waterman—For Plaintiffs—Recalled— 1681
Rebuttal—Direct.

By Mr. Ashton:

Q. In a special situation? A. Yes.

Q. Now the Pierce Patent 1,127,371; tab No. 9, also shows a potentiometer used in a highly gaseous audion circuit. What was its purpose in this patent? A. A potentiometer 60 is shown having the adjustable tap 63 in Fig. 2. The purpose is to take off a desired bias to the grid of the tube 13, so that after the tube has gone dead, or "plugged" as the expression used to be, the restoring relay 51 will restore it, that is the grid, to a definite potential selected in accordance with the particular sensitiveness of adjustments that initial control of the filament called for. Dr. Pierce, as I explained, and as he points out at the bottom of column 1 of page 1, is trying to reconcile a state of high sensitivity in the gas discharge with operability if strong signals come in.

Q. Now the Colpitts patent 1,137,384, tab No. 13. Will you point out the features of this circuit which Mr. Cloud referred to—I believe the resistance 26 in Fig. 2?

Mr. Ashton: I will point out, your Honor, that the plaintiffs' position is that this patent has been antedated, and even if it were not, it has no bearing on the invention of the patent under consideration.

A. As I explained yesterday, the patent goes to the operation of a tube in the combined capacities of oscillator and modulator. That requires that the amplitude of the oscillations and of the modulating voltages due to the micro-

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1684 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Direct.

phone must be very carefully coordinated with one another. The purpose of the resistance 26 shunted across the secondary of the transformer 14 is to more or less short-circuit the transformer, thus absorbing in the transformer itself more or less of the energy of the signal from the microphone, in order to govern the modulation with respect to the intensity of the oscillation. The latter is governed by the various adjustments that I referred to yesterday describing this patent in another connection.

1685

By the Court:

Q. Is 26 the potentiometer? A. No, it is a variable resistance. The same is true of 26 in Fig. 4. It is not a potentiometer in either case; merely a series rheostat.

By Mr. Ashton:

1686

Q. In the case of Fig. 4, in order to make it into a potentiometer you would have to connect the two resistances together and take off one of the taps there, would you not? A. That is correct.

Mr. Ashton: I will point out, your Honor, that the Kendall Patent 1,330,471, discussed by Mr. Cloud, has been antedated and no testimony will be taken on that. The same is true of the Van der Bijl patent 1,350,752.

Q. As I recall Mr. Cloud's testimony, he stated that he was familiar with the use of potentio-

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Frank N. Waterman—For Plaintiffs—Recalled 1687
Rebuttal—Direct.

meters from perhaps 1912 or earlier, but he did not know of their use in connection with vacuum tubes across the input circuit until some time later, perhaps 1915, I think it was. You yourself stated, I believe, that you had audions at an early date. What was the date that you first had them? A. I don't recall exactly. I think it was the winter of 1911 or 1912 that I began to work with the audion. No. I guess it was 1912 or 1913. It was one of those winters.

1688

Q. Did you place such a potentiometer across the input? A. No. No, I did not. I did not entertain that idea.

Q. Look at the Johnson Patent 1,432,863, and state whether that shows a potentiometer. That is Tab No. 31. As to that patent will you state whether it discloses a potentiometer in the input circuit? A. It does not. The resistance 12 in Fig. 1, and 26 and 28 in Fig. 2, are merely variable rheostats connected across the primaries of the input transformers for the tubes 9, 15 and 18.

1689

Mr. Ashton: I will point out, nevertheless, your Honor, that this patent is antedated, filed in 1918.

Q. Is this a correct statement with respect to the invention of the Arnold patent in suit which we are referring to—that it permits adjustment of amplification without changing the impedance facing the potentiometer on its input side, and that the device is located on the input side of the tube? A. Yes.

Q. With respect to all prior art patents as to which it is not plaintiffs' position that they have

1690 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

been antedated, do you find any that shows a potentiometer across the input circuit? A. I do not.

Q. Do you find any arrangement which provides for adjustable amplification similar to the adjustment in the Arnold patent in suit? A. No.

1691 Q. Do you find any arrangement which varies the amplification without affecting the impedance facing the input side of the potentiometer? A. I do not.

Cross Examination by Mr. Darby:

Q. You would agree with me, Mr. Waterman, would you not, that prior to any date with which we are concerned in this litigation the use of condensers, inductances, resistances and batteries in audion circuits was known? A. Yes. Your question is so broad that it certainly can be assented to.

1692 Q. In other words, there is nothing novel in those instrumentalities as such, in connection with audion circuits? A. Not in the very broad way that you state it.

Q. I intended it to be broad. Will you also agree with me that it was the custom prior to that time—

The Court: Prior to what time?

Mr. Darby: Prior to the earliest date with which we are concerned for the invention of any of the patents here in suit.

Q. (Continuing.) —to use different values for condensers, batteries, inductances, resistances, depending upon the particular use to which the

Frank N. Waterman—For Plaintiffs—Recalled 1693
Rebuttal—Cross.

instrumentalities were put? A. Why, that is a question of electrical engineering, and those things are always adjusted for the purpose that you want to attain. As you state your question you do not make it any different than any other engineering matter. You use them as far as your knowledge permits you to use them.

Q. And that it was known in connection with vacuum tube circuits that different values for inductances and resistances would have different effects in the circuits in which they were employed? A. Well, that might be a presumption. I do not think your question is answerable.

Q. You know, do you not, that the values of the inductances and resistances in audion circuits differed when they were employed for audio-frequency currents than when they were employed for radio frequency currents? A. If you wanted to accomplish the same purpose you would use a different order of inductance in an audio frequency tuning, for example, from what you would in a radio frequency tuning, of course.

Q. Referring now to B battery supply, varying values of B battery were employed and have been employed since the early days of the audion, have they not? A. Yes, the early audions used to be put out with a variable battery switch, because the audion one day would stand one battery and another day another, and it was necessary often to change the battery to kill the blue haze effect.

Q. Will you please turn to the Arnold patent 1,520,994 in suit, Tab H, and likewise the Arnold patent 1,448,550, Tab F. Both of those patents disclose an impedance numbered 6 in

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1696 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

Arnold patent 1,448,550, and numbered 25 with reference to audion tube numbered 11 in Arnold patent 1,520,994, which impedance is connected in shunt to its associated transformer coil in the input circuit of the audion with which it is connected; is that correct? A. Yes.

Q. Now will you please turn to the Arnold patent No. 1,129,942, Tab No. 10, and also Arnold patent No. 1,129,943, which is Tab No. 11, and I call your attention to the fact that Arnold patent 1,129,943, Tab No. 11, makes reference at line 100, page 1, to an application for patent identified as "Serial No. 841,568 filed of equal date herewith," and by comparison with the serial number of the application on which Arnold patent 1,129,942 Tab No. 10, issued, I think you can identify that as the application referred to. Is that right? A. Yes.

Q. Do these patents disclose the subject of varying the spacing of the electrodes for the purpose of changing the impedance internal of the glass envelope? A. Yes.

1698 Q. Now keeping Arnold patent 1,129,943, in mind, is there shown in this patent a thermionic discharge device having a cathode, an anode and a control element; and if so will you give the reference numerals employed to designate them? A. Referring to 1,129,943?

Q. Yes, si.; say Fig. 1. A. The anode is shown at 2, the cathode at 3, and the control element at 1.

Q. And taking any particular vacuum tube, let us say take the one marked 4, has it an input circuit? A. Yes.

Q. That is the circuit that is connected be-

Frank N. Waterman—For Plaintiffs—Recalled—1699
Rebuttal—Cross.

tween the grid and the filament of that tube; is that right? A. Yes.

Q. Has it an outgoing circuit? A. Yes.

Q. And that is the circuit that is connected between the plate and the filament; is that right? A. Yes.

Q. And is there an impedance in that output circuit? A. Yes.

Q. Still referring to the Arnold patent No. 1,129,943, is there a source of electromotive force in the input circuit of the particular tube we have under consideration? A. Yes. 1700

Q. And is there a source of electromotive force in the output circuit of that tube? A. There is.

Q. And is the resistance 8 or the impedance offered by resistance 8 and the battery 9 of a high order? A. The specification, page 2, line 45, says it should be, for example, 100,000 ohms or more.

Q. You would consider that of a high order? A. And in line 44 it is referred to as a "high resistance. Well, "high" and "low" are relative terms, of course. 1701

Q. I notice that you looked through the specification to obtain a value for the resistance. No value can be obtained merely from an inspection of the symbol used in the drawing; is that right? A. That is correct.

Q. Any resistance in the output circuit is bound to have an effect on the output current; is that correct? A. Well, I don't think it is. It is too generally stated to permit of an answer.

Q. I am referring specifically to the Straight Line Characteristic Patent now. That is what I have in mind in this cross examination. If the

1702 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

resistance 8 was of a low order, what effect would it have on the straight line characteristic of the tube? If it is considerably lower than 100,000 ohms what effect would it have on the straight line characteristic of the tube? A. I don't know. That is a question not determined by the mere absolute magnitude of the external resistance.

1703 Q. What is there in addition to that that you have to know? A. It depends on the relation of the external resistance under the alternating current path of the impedance, more broadly, as compared to the alternating current-plate circuit impedance within the tube.

Q. Are the tubes as shown in Arnold Patent 1,129,943, repeater tubes? A. Yes.

Q. And they are used as such in the patent? A. Yes.

1704 Q. Now, turn to Patent No. 1,129,942, which is Tab 10; referring to the coupling between the first tube marked 1 in Fig. 6 and the second tube marked 1 in Fig. 6, reading from left to right, do you agree that the two tubes are coupled together by a resistance coupling? A. No, they are not.

Q. In the normal operation of the arrangement shown in Fig. 6, is there produced potential variations across the left-hand resistance 14? A. They are not—probably not in the sense in which you mean; of course, there are potential variations.

Q. There are potential variations. It is the fact that the resistance as used, makes it unavoidable that there should be some potential variation, is not that correct? A. Yes, that is correct, but that combination of resistance and

Frank N. Waterman—For Plaintiffs—Recalled 1705
Rebuttal—Cross.

condenser is a peculiar one, and what happens in the resistance, depends on what is known as the time constant of the circuit through the upper condenser 18 and the resistance 14 back to the filament circuit.

Q. The resistance 14 is connected between the plate electrode 4 of the first tube to the filament electrode, is it not?

The Court: I don't understand the question. Are you talking about the first tube on the left now?

1706

Mr. Darby: Yes, your Honor.

The Court: Just read that question.

(Question read.)

A. No, that certainly is not a correct way of describing it in any ordinary use; it is connected between grid 3 of the second tube and a filament 5 of that same tube.

Q. And is there any circuit leading from the plate 4 of the first tube through the resistance 14 to the filament of the first tube? A. Oh, yes, you can trace all sorts of circuits there.

1707

Q. And I think you just stated that the resistance 14 is also connected between the grid electrode 3 of the second tube and filament electrode of the second tube, is that correct? A. That is where it is connected. That is the significant connection.

Q. All of the circuits are significant, are they not, Mr. Waterman? A. Not necessarily.

Q. They are so shown as complete circuits, are they not? A. You can trace circuits that have absolutely no significance, and a great many more of them in fact, than significant ones.

1708. *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.*

Q. Irrespective of the significance of them, I am endeavoring now to establish what is shown in this drawing—the circuits that are shown in this drawing. A. You may trace paths—you understand these connections are not circuits. A circuit is something in which the operating current flows, and you can trace various paths in which they do not flow.

Q. Do you mean to say that current does not flow through the resistance 14? A. No, I have explained that the current from the battery 11—or rather the potential from the battery, 11 flows through the resistance 14; in other words, 14 is there primarily, and first of all, to enable the charge to be imparted to the grid 3. It is also there to permit a discharge path for the condenser 18, in order that the tube which is the middle tube in Fig. 6, may not block or plug.

Q. It serves exactly the same purpose in the connection that is shown between the middle tube and the tube on the right-hand end, is that right? A. With respect in that instance to the right-hand tube.

Q. Yes. And will you trace the output circuit for the plate electrode 4 of the middle tube for me? A. The direct current circuit of the middle tube is from the battery through the resistance 17 to the plate 4 thence to the filament and back, the alternating current circuit is through the upper condenser 18, the resistance 14, the lower condenser 18 back.

Q. To get the matter perfectly clear on the record, starting from the plate 4 of the middle tube, the output circuit— A. No, I am wrong about that. I was right in the first instance, Mr.

*Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.*

1711

Darby. That is not the alternating current output circuit. The alternating current output circuit is through the reactance 17.

Q. Starting from the plate electrode 4 of the middle tube, will you agree with me that the output circuit starts from that electrode and goes to the point where it branches, part going through the condenser 18, part going through the inductance 17 and part going through the resistance 14 and then back to the filament electrode; will you agree or disagree with that? A. Will you let me have that question read?

1712

(Question read.)

A. Well, that would necessarily be so in any case, but your question goes to something that I had not noticed before. That circuit can be looked at in two ways. I had not discovered that before.

Q. I think you have answered my question. A. You were looking at it in a different way from any way that I had ever looked at it before. I see that it can be looked at in that way.

1713

Q. I thought we were talking at cross purposes and I wanted to get a simple statement.
A. Yes.

Q. And of course, you will agree with me that the condenser 18 is connected in the lead between the plate electrode of one tube to the grid electrode of the next tube, will you not? A. Oh, yes, certainly. In either view, that is true.

Q. Now, will you please turn to Colpitts Re-issue Patent No. 14,390, Tab 17. Is there there shown a vacuum discharge device of a three-electrode type? A. Yes.

1714 Frank N. Waterman For Plaintiffs—Recalled
Rebuttal—Cross.

Q. And is there there shown, and if so will you please point out, referring for example to Fig. 2, an inductive coil conductively connected to the input electrodes of the device; I refer primarily to the transformer coil. A. You refer to modulator transformer 14, yes. Wait a minute, no, it is not conductively connected.

Q. The transformer coil 14 is not conductively connected! A. To the input electrodes! No, it is capacity connected.
1715

Q. And is there a conductive impedance in shunt to that coil? A. No, except through the capacitance.

Q. There is an impedance in shunt to that coil, is there not, namely the resistance 26? A. No, it is in shunt to the coil 14 and the unlettered condenser, which are in series with one another.

Q. So that it is in shunt to the coil and the condenser, is that right? A. Taken together, yes.

1716 Q. And the impedance element 26 is conductive, is it not? A. Yes, certainly.

Q. Now, will you again refer to the Arnold Patent 1,129,942, Tab 10. I think you will agree with me that this patent shows a common source of current for the plate electrodes of all the tubes, will you not? A. It does in certain figures, yes.

Q. Now, referring to Fig. 6, which of the batteries do you understand to be the B battery supply, for supplying voltage to the plate circuit? A. Battery 13.

Q. What is the path of travel of the current from that battery to the plate electrode 4? A.

Frank N. Waterman—For Plaintiffs—Recalled— 1717
Rebuttal—Cross.

Through the reactance 17, across the tube to the filament and back to the negative end of the battery.

Q. And that reactance 17, do you understand that to be a series inductance? A. I have been taking it to be the coupling reactance, so of course, it is a series inductance.

Q. And the series inductance is bridged by condenser 18 and resistance 14, is it not? A. That combination constitutes a high resistance path around the reactance 17, yes.

Q. Now, will you please turn to Tab 23, which is Von der Bijl Patent No. 1,350,752. You will agree with me, will you not, that what you understand to be the invention of Arnold Patent 1,520,994, as defined in the claims of that patent in suit, is illustrated in Fig. 4 of the Van der Bijl patent, in so far as the potentiometer 10 is concerned? A. There is such a potentiometer in the input circuit. It is not in that case, however, the sole source of voltage in the input circuit and its use is for quite a different purpose.

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Q. Then turn to Kendall Patent 1,330,471, which is Tab 20. Will you agree with me that the invention defined in the claims of the Arnold patent in suit No. 1,520,994 is completely illustrated in the potentiometer 84 of Fig. 4? A. It seems to be, yes.

Q. Now, will you please turn to the De Forest Patent 841,387, Tab No. 1; is it not true, with respect to this De Forest patent, as well as De Forest Patent 879,532, Tab No. 2, and De Forest Patent 995,126, Tab No. 4, that wherever there is illustrated a three-electrode audion device,

1720 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

the control electrode is connected to the negative side of the filament battery?

The Court: Can you substitute for "control electrode," the word "anode"?

Q. Control or grid electrode. The control electrode is the grid electrode and is always connected to the negative side of the filament battery, is that true? A. No, that is not true.

1721 Q. Show me any instance where it is not true, will you? A. That is not true of either figure in Patent 879,532, and it is not true in 995,126.

Q. In no figure, did you say? A. Yes.

Q. All right, let us take Fig. 2 of De Forest Patent No. 841,387; you understand electrode D¹ is the control electrode? A. I did not say anything about 841,387. I was just coming to that. In 841,387, the control electrode, which is not a grid, but is the plate D¹, and is in a circuit through the detector T¹¹ to the negative side of the filament E.

1722 Q. Then you disagree with my statement. What is the control electrode in Fig. 3 in this patent? A. Of 841,387?

Q. Yes. It is the device a, is it not?

The Court: That is small a?

Mr. Darby: Small a, yes, your Honor.

The Witness: No, there is not any control electrode in that case.

Q. Isn't that device a the control electrode to which the input electrode is connected? A. No, it is a mechanically operated device in which

Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

1723

the filament is jerked back and forth with reference to plate D.

Q. Take Fig. 4 on the next page, that is a three-electrode device, is it not? A. Yes.

Q. Which is the control electrode? A. D¹.

Q. To which side of the filament battery is the control electrode connected? A. Neither side.

Q. Is there not an input circuit between the grid and filament? A. The circuit is connected to the negative side, but the control element is not.

1724

Q. I will restate my previous question, and maybe we will agree. Is it not a fact, in every instance in these three De Forest patents that I have mentioned where three-electrodes are employed, one of which is a control or grid electrode, that there is a circuit connecting the grid electrode to the negative side of the filament source? A. No, you are wrong there, unless you limit your question so as to exclude a direct current connection; otherwise you are making a misleading statement in your question.

1725

Q. I said "circuit connection," adopting your own language, just a minute ago. A. All right, and I made my answer clear. If I did not, then I was at fault. The circuit connects through a condenser, therefore, so far as imparting any bias to the control electrode is concerned, it just does not.

Q. Mr. Waterman, you realize that I have not asked you anything about bias, do you not? A. I know you haven't, but I know what you are cross examining about, and as I said in my direct examination, these are the customary circuits. It was customary at that time to put the

1726 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

signal between the control element and the negative side of the battery.

Q. Now, will you please endeavor to answer my questions rather than anticipate why I am asking them, and I think we will make much better progress. Will you answer my question now. Is it not a fact that in every one of the circuit diagrams illustrated in the De Forest patents where three electrodes, one acting as a control or grid electrode is employed, that the grid or control electrode is connected by a circuit, irrespective of whether it is direct current or alternating current, to the negative side of the filament battery? A. No, that is not true.

1727 Q. All right, take No. 841,387, is it true with respect to that Fig. 4? A. It is not true, irrespective of what kind of current you are talking about.

Q. Is there a circuit connection between the electrode D1 and the filament in Fig. 4 of De Forest Patent 841,387? A. No.

1728 Q. There isn't any circuit connection between them at all! A. No, your question is limited, irrespective of AC or DC, and if so, your statement is not correct.

Q. Just forget everything that has gone in the past and answer me this question: Is there a circuit connection between the electrode D1 of Fig. 4 of De Forest and the filament of the tube? A. There is an alternating current circuit.

Q. There is a circuit connection? A. There is an alternating current circuit. There is no direct current circuit.

Q. Is an alternating current circuit, a circuit,

Frank N. Waterman—For Plaintiffs—Recalled 1729
Rebuttal—Cross.

in your opinion? A. It is one of a number of types of circuit.

Q. Therefore it is a circuit? A. It is an alternating current circuit, yes.

Q. Now, turn to De Forest Patent No. 879,532; is there a circuit between the plate electrode A, Tab No. 2, and the filament electrode in that tube? A. An alternating current circuit, yes.

Q. Is that connection made to the negative side of the battery that heats the filament? A. Yes.

Q. Look at the figure below, Fig. 2. A. The same is true.

Q. Is the same true of all the other circuits of the De Forest patent, tab No. 4, Patent No. 995,126? A. Referring to the tubes A¹—yes, there is an alternating current circuit connected to the control electrode and to the negative side of the filament.

Q. Your answer is based upon the fact that in each instance the patent designates the polarity of the battery for heating the filament, is that right? A. Yes.

Q. Now, do you know why in these various audion circuit arrangements that we have been discussing—referring to these De Forest audion circuit arrangements—all these De Forest patents—the connection of the circuit between the grid and the filament was made to the negative side of the filament battery? A. I do not know anything about De Forest's mental operations, if that is what you mean. The art started that and continued for a long period. As far as I know, it is generally true today.

Q. Referring to De Forest Patent No. 841,387

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1732 Frank N. Waterman—For Plaintiffs—Recalled
Rebuttal—Cross.

again and particularly Fig. 2, I think you referred to the device marked T¹¹ as an oscillation detector. Did all oscillation detectors require sensitizing current, and if not, what types did not? A. Well, prior to the date of the application for the patent in suit, as far as I know, most of them did. Whether there are any that did not up to that date, I do not recall.

1733 Q. Crystals, other than carborundum do not require sensitizing? A. As far as I remember, carborundum was the only crystal that was available at that time, but I would not want to be too sure of my memory.

Q. You testified as an expert in the case of crystal detectors, did you not? A. Yes, I did. I have quite forgotten the date, but my recollection is that the carborundum crystal was the only one that was available that was actually worked in the art, until a little later.

Q. You do not recall that you testified that crystal detectors were available prior to 1907? A. No, but if you will let me see—

Q. I am asking for your recollection. A. I want to know what the facts are.

Q. All right, I will enlighten you on that. I can give you one that might refresh your recollection, the silicon detector, don't you recall that was used in 1906? A. No, I would not be able to recall that, because I was not working in the art then. The first silicon detector I had was provided with a battery for sensitizing it, but I do not recall getting that until much later.

Q. During the recess, I will refresh your recollection, Mr. Waterman. I have no intention of

Frank N. Waterman—For Plaintiffs—Recalled— 1735
** Rebuttal—Cross.*

misleading you on it. Where a sensitizing battery was used, was current flow necessary? A. In every case that I know of, yes.

Q. Have you ever heard the expression of a "floating grid" in connection with these vacuum tubes? A. Oh, yes. All the early use was by floating grid.

Q. What is meant by that? A. It means that there is a condenser in the path to the grid from the input source, whatever that may be, so that the potential of the grid floats, as the expression is, with reference to the filament. It is then determined in the absence of any signal,—it is determined by what are termed by contact and maybe anywhere from a volt or so positive to a volt or so negative and when it is connected to a source of signal, then the potential will fluctuate in accordance with the signal and whatever the cumulative effect of the condenser in the lead may be.

Q. You are familiar with J. H. Morecroft; you know him, do you not, Professor Morecroft? A. Yes, he died a short time ago, and I was very sorry to hear it.

Q. He is considered an authority in the radio science, is he not? A. Oh, yes.

Q. He was Professor at Columbia University of electrical engineering? A. Yes.

Q. Are you familiar with his book, "Principles of Radio Communication"? A. Yes.

Q. With respect to this question of the floating grid—first let me ask you this: All of the early type of audion tubes, such as you produced from your collection were generally known as the old De Forest type, is that right? A. That is right.

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1738 Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.

Q. And they were all very gassy, I think you have testified, that is, they did not have a high degree of vacuum. A. The vacuum varied very greatly, and when they were new, none of them had very high vacuum.

Q. Let me read this to you from Professor Merecroft's book, with which you expressed familiarity:

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"In Fig. 27 is shown a set of plate-current curves from an old De Forest audion, after it had been re-evacuated to take off all possible gas. The plate circuit had no added resistance except that of the B battery, which was so low that the variation in plate current did not appreciably affect the plate potential. On the curve sheet is shown the locus of the 'free grid potential,' i. e., the potential at which the grid set itself when its external terminal was completely insulated. This point will be taken up more in detail later."

1740

Then he goes on:

"For the tube used in getting the curves of Fig. 27, it will be noticed that the grid voltage was more effective (in controlling the plate current) than the plate voltage in the ratio of about two to one."

He then gives some mathematical formulae that I do not think it is necessary to read. Do

*Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.*

1741

you disagree with that statement of the matter of the floating grid? A. I do not see anything to disagree with, Mr. Darby. I could not disagree with him; I did not perform his tests.

Q. Do you see anything scientifically wrong in his statement, or the results illustrated by the curve that he refers to? A. No, he has taken an old audion and gotten something that nobody ever did with one of the originals. He got a consistent set of curves out of it.

1742

Q. And you notice he said in there, "insulating the grid," that is the type of insulation that you referred to with reference to the De Forest patent, where you pointed out that the grid was insulated from the condenser by a grid filament lead, is that right?

Mr. Ashton: Would you mind stating what the date of the publication of the book is?

Mr. Darby: Not a bit. This particular book that I am reading from was copyrighted in 1921 and it is dated April, 1921, Columbia University, Professor Morecroft.

1743

Q. You made reference to the De Forest audion and Dr. De Forest. You are familiar, are you not, with an article by Dr. Lee De Forest: "THE AUDION. A New Receiver for Wireless Telegraphy," presented at the 210th meeting of the American Institute of Electrical Engineers, October 26, 1906? A. Yes, I have seen the article.

Q. I think I have had the pleasure of dis-

1744 *Frank N. Waterman—For Plaintiffs—Recalled—
Rebuttal—Cross.*

cussing it with you across the witness stand before. In this article there is contained this statement, which I will read, and you may check my reading:

1745

"The manner in which the audion should be located in the oscillating circuit, as well as many other considerations, shows conclusively that it is a 'potential-operated' rather than a 'current-operated' relay receiver. At the same time its advantageous sluggishness of action, as explained above, renders it additive in its response to the energy of an entire wave-train or even of a series of wave-trains. Hence its excellent and marked selective qualities."

Do you agree with that statement? A. I will have to look at the article. I think he is referring to the condenser action, is he not?

1746

Q. No, I was under the impression that he was referring to the operation of the tube; it may be to the condenser, but it is immaterial from my point of view. A. I do not know what he means by its advantageous sluggishness of action. I would have to read the article to find that out. I think he is referring to the detection phenomenon there, Mr. Darby. He uses the word "sluggish" I imagine in the sense that we ordinarily use the word integrating action.

Mr. Darby: That completes my cross-examination of Mr. Waterman. I will either at this time, or at a more appro-

*Franklin T. Woodward—For Plaintiffs—
Recalled—Rebuttal—Direct.*

1747

priate phase of the case, will offer in evidence a reproduction of the curves referred to in the Morecroft book. May I do it now?

The Court: If there is no objection.

Mr. Ashton: None.

Mr. Darby: I would like to offer in evidence copy of the curves referred to as Fig. 27 in the passage of Professor Morecroft's book just read to the witness, and I understand that I will be permitted to substitute a photostatic copy for the book.

(Marked Defendant's Exhibit N.)

1748

Re-direct Examination by Mr. Ashton:

Q. I have only one question to ask: Whatever De Forest may have been referring to as potential operation, in the article referred to by Mr. Darby, is what is meant by potential operation defined by Lowenstein in his patent? A. Yes, namely, a condition in which the grid circuit 1749 does not take energy from the line.

Q. Does Lowenstein refer to that operation as ultra-negative potential operation? A. He does.

FRANKLIN T. WOODWARD, recalled, testified further as follows:

Direct Examination by Mr. Ashton:

We made investigations of the De Forest patents for a long time, but the particular one that

1750 *Franklin T. Woodward—For Plaintiffs—
Recalled—Rebuttal—Direct.*

I have in mind, and I think what you referred to was in 1927. We made an investigation of the De Forest patents including two Ries patents and reported to Mr. Otterson.

Q. And what was your report?

Mr. Darby: What is the relevancy of this, may I ask?

1751 Mr. Ashton: The relevancy is this: The witness Otterson who testified yesterday, as a result of an objection which does not appear in the record, that this reported study of the De Forest patent was made and the results were reported and the Western Electric Company was not interested. Mr. Schlesinger states that he had this interview in which these patents were discussed and I wanted to bring out that the Electrical Research Products and Western Electric Company were not interested, as such, in the De Forest patents.

1752 Mr. Darby: I do not think that that bears on this case at all. It is not the De Forest patents that are on trial.

Mr. Ashton: I think the point is, if your Honor understands—

The Court: I think I do, and I think I will sustain the objection with exception.

A suit was brought against the Stanley Company, which we defended.

Mr. Darby: That is stipulated.

The Court: The Western Electric Company defended the suit against the Stanley Company?

*Franklin T. Woodward—For Plaintiffs—
Recalled Rebuttal Direct.*

1753

Mr. Ashton: Yes, the title of the suit was General Talking Pictures Corporation and De Forest Fonofilm vs. Stanley Company of America.

Mr. Darby: That is all stipulated.

Q. One further question: Did the court hold that any of the patents were infringed?

Mr. Darby: Just a minute. I have given the Court citation of the authorities. Why ask this witness. It is a public record; it is in the Federal Reporter.

1754

The Court: Are any of the patents here in suit involved?

Mr. Ashton: No, they are not. The De Forest patents which Mr. Otterson was talking about—

The Court: That is a matter that can be ascertained by looking at the cases, is it not?

Mr. Ashton: That is quite agreeable to me, your Honor. That is all.

1755

Mr. Darby: I have no questions.

Mr. Neave: I think if Mr. Darby will make a stipulation we need not offer these documents.

Mr. Darby: It is stipulated that it is common practice where a patented invention is applicable to different uses, to grant written licenses to manufacturers under United States Letters Patents restricted to one or more of the several fields of use permitting the exclusive or non-exclusive use of the invention by the

1756 Paul H. Pierce—For Plaintiffs—Rebuttal
Direct.

licensee in one field and excluding its use in another field. I stipulate that and I urge, however, objection to its receipt for any evidential purpose, as irrelevant and immaterial what the common practice is, on the issue of law as to whether or not it is legal.

The Court: That goes strictly to the question of the effect to be given to the stipulation, but not the capacity of counsel to stipulate to a fact.

1757

Mr. Darby: Yes, you are right.

The Court: That is all we are talking about now.

PAUL H. PIERCE, called as a witness on behalf of the Plaintiffs in Rebuttal, being duly sworn, testified as follows:

1758

Direct Examination by Mr. Ashton:

My name is Paul H. Pierce. I reside at 417 Highland Avenue, Westfield, New Jersey. I am employed by Electrical Research Products, Inc., as an engineer in the engineering department. I entered the employ of the Western Electric Company in July, 1911.

As to what work I did under Dr. Harold D. Arnold's direction, in the design of vacuum tubes, and their characteristics and use, in the latter part of 1912 and during all of 1913 I worked on the characteristics of vacuum tubes under Dr. Arnold. This work involved the determination of input and output impedance of

*Paul H. Pierce—For Plaintiffs—Rebuttal—
Direct.*

1759

tubes. I had to do with their operation in circuits to obtain maximum power output. I made tests for that purpose.

I first learned that a 3-electrode vacuum tube had impedance in the Fall of 1912. I learned it from Dr. Arnold. I first learned that the impedance of the output circuit of a 3-electrode vacuum tube might be matched to the impedance of the work circuit in the Fall of 1912, from Dr. Arnold. I did work under Dr. Arnold's direction for the purpose of determining under what conditions a tube would give maximum power output. I carried out experiments which have been recorded in my notebook for that date, for that period, in which I made measurements of circuits and the output of vacuum tubes, and measured the power into those circuits. I found that the power output was maximum when the external impedance was matched by the impedance of the tube. I can fix the date by this memorandum. This is my own memorandum-dated December 18, 1912. I prepared it on this date, December 18, 1912. The data and definitions given in this memorandum on pages 1 and 2 show that I was dealing with the alternating current impedances and currents within the vacuum tube.

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Mr. Ashton: I offer the memorandum in evidence as Plaintiffs' Exhibit 43, and ask that a copy be substituted.

(Marked Plaintiffs' Exhibit No. 43.)

All during 1913 I made tests under Dr. Arnold's direction on audions having different

1762

*Paul H. Pieroe—For Plaintiffs—Rebuttal—
Direct.*

types of grid structures, and different spacings of the elements therein. The Research Department made several tubes in 1913 which differed from the De Forest tubes as to geometry. It made a tube given the number 39. If I may refer to my notebook I can describe it more in detail. This tube had two plates, two grids and one filament. One grid on one side of the filament was a large loop, the one on the other side of the filament was a small loop. This is shown in a picture in Book No. 36 on page 53.

1763

The Court: Can you give the date?

I have entries of my own in that notebook. In this book I find entries of my own on page 80. The first one I find is on page 69, dated October 23, 1913. On page 190 of my notebook 20 I find a record dated October 2, 1913, of new audions, made September 30th and October 1st, one of which is this same audion No. 39. This Book 20 was kept by me.

1764

Mr. Ashton: I offer in evidence page 190 of the witness' notebook 20, page 53 of notebook 36, and page 59 of notebook 36, as three exhibits.

(Marked Plaintiffs' Exhibits Nos. 44, 45 and 46.)

The grid or grids of this tube 39 has a very open structure. It would reduce the impedance of the tube. The side having the larger grid opening would have the lower impedance.

I could compare this tube 39 with tube No.

Paul H. Pierce—For Plaintiffs—Rebuttal 1765
Direct.

7-A, which was a De Forest type tube, and the data on which was recorded in my Book No. 20, on pages 32, 33, 34 and 35. I would have to take a particular voltage for each tube which was comparable. I find for audion No. 39, which is the one with the large grid opening. I find that with a plate voltage of about 20 volts and a grid potential of zero, the space current was 1,460 micro-amperes. In the typical De Forest audion No. 7-A which was recorded on pages 34 and 35, under the same conditions of voltages on the plate and grid the space current was 310 micro-amperes.

1766

I got this tube 7-A from the McCandless Company, I think, who manufactured the tubes, the De Forest tubes. Tube 39 and other Western Electric tubes were made and designed under Dr. Arnold's direction. I measured other tubes in which the separation between the grid and filaments was different. I can fix the date of such measurements as in December, 1913. We made such measurements. I find a record of one tube on December 15, 1913, tube No. 158, which is recorded on page 16 of Book No. 50. It shows a diagram of a spacing in this tube in which the plate and grid spacing on one side was different than the spacing of the grid and plate on the other side of the filament.

1767

Mr. Ashton: I offer in evidence this page 16 of Notebook 50, which relates to audion No. 158.

(Marked Plaintiffs' Exhibit No. 47.)

I also worked on audions having different grid meshes.

1768 Paul H. Pierce—For Plaintiffs—Rebuttal—
Direct.

Drawing ES111730, dated January 6, 1914, is a curve which I worked on. This is a curve taken from the data on page 56 of Book 50. It shows the characteristics obtained with two vacuum tubes, one of which had a grid wire mesh of six wires in one direction and four in the other, and another one with three wires in one direction and three in the other, as shown on the curve.

1769

Mr. Ashton: I offer pages 56 and 57 of Notebook No. 50 in evidence as Plaintiffs' Exhibit 48.

(Marked Plaintiffs' Exhibit No. 48.)

Mr. Ashton: I offer in evidence sketch ES111730, dated January 6, 1914, as Plaintiffs' Exhibit 49.

(Marked Plaintiffs' Exhibit No. 49.)

I made this sketch last referred to at the time it is dated. The tubes referred to on the sketch ES111730 were made under Dr. Arnold's direction. The conclusions as to the effect on the output impedance of these two structures of the grid meshes were that the output impedance of the tube having the larger grid mesh was the lower.

Those were not the only tubes that we experimented with. We experimented with a great many having different types of grid meshes and different spacings during that time. I made measurements to determine the relation of the tube impedance to the load impedance. I can fix the date of such measurements. I find in February, 1913, a sketch which I made at that

*Paul H. Pierce—For Plaintiffs—Rebuttal—
Direct.*

1771

time, on page 73 of Book No. 20. This gives a lot of data obtained in measuring the input impedance of a vacuum tube No. SS, and also data giving the output impedances and the circuit in which this data was taken. The circuit appears on page 73.

Mr. Ashton: I offer in evidence page 72 of Notebook 20 as Plaintiffs' Exhibit No. 50.

1772

(Marked Plaintiffs' Exhibit No. 50.)

Mr. Ashton: And page 73 of the same notebook, as Plaintiffs' Exhibit 51.

(Marked Plaintiffs' Exhibit No. 51.)

This memorandum dated March 15, 1914, is a memorandum in Dr. Arnold's handwriting, which I understand came from his files. It was obtained from the Bell Laboratories files. It is dated March 15, 1914. The lower curve on page 4 shows a straight line characteristic. This curve was obtained on a vacuum tube with a resistance in the plate circuit.

1773

Mr. Ashton: I offer the memorandum in evidence as Plaintiffs' Exhibit 52.

(Marked Plaintiffs' Exhibit No. 52.)

This is a memorandum which I wrote on March 19, 1914, in my own handwriting. The date 1913 appearing at the top is an error. It was 1914. The complete date was March 19, 1914. The subject of this memorandum is experimental audions. It has sub-headings of Grid Distance, Grid Opening, and is a record of work

1774 Paul H. Pierce—For Plaintiffs—Rebuttal—
Direct.

which I did at that time under Dr. Arnold's direction. I made the report to Dr. Arnold. That had to do with results obtained with different grids.

Mr. Ashton: I offer in evidence the memorandum last referred to by the witness, of March 19, 1914, as Plaintiffs' Exhibit 53.

1775 (Marked Plaintiffs' Exhibit No. 53.)

This is a memorandum which was prepared by Mr. Arnold, addressed to Mr. Colpitts, dated April 17, 1914, which describes audion amplifiers without transformers. This memorandum discloses in the drawings a common plate supply. I recognize the writing at the bottom, below the figures. This is Mr. Arnold's writing. Professor Arnold's: The common plate supply is marked V^1 . The battery is V^1 . There are three tubes supplied by battery V^1 .

1776 Mr. Ashton: I offer the memorandum in evidence as Plaintiffs' Exhibit No. 54.
(Marked Plaintiffs' Exhibit No. 54.)

Dr. Arnold developed vacuum-tubes, so that they would amplify telephonic currents without distortion. The tubes which he developed would permit the use of smaller gauge and less expensive transmission lines than would otherwise have been required. They undoubtedly resulted in economies in long distance transmission. In addition to high vacuum, Dr. Arnold recognized the existence and the importance of

Paul H. Pierce—For Plaintiffs—Rebuttal— 1777
Direct.

the space-charge effect of electrons in the high vacuum tube. He calculated the magnitude of this effect and methods for its adaptation to commercial purposes.

Q. Did he develop theories as to means of obtaining proper physical—

Mr. Darby: Just a moment, this is fact testimony of such a nature, that I must request that you do not lead the witness on this.

1778

Mr. Ashton: These particular questions are not specific with regard to the particular invention, but merely the broad work which Dr. Arnold did on the vacuum tube. The questions regarding the exact dates of these inventions, have already been answered.

Mr. Darby: Yes, I understand, but let the witness testify to these things.

Mr. Ashton: I am trying to make as much time as possible.

1779

The Court: Mr. Darby speaks as one in authority when he makes an objection on that ground in these matters.

By Mr. Ashton:

All of Dr. Arnold's work led up to the design of vacuum tubes so that they could be manufactured with accuracy. So that their characteristics could be reproduced. He studied the static characteristics of the audion and I assisted him in much of this work. I was one of his special assistants at the time he was doing this work.

1780 *Paul H. Pierce—For Plaintiffs—Rebuttal—
Cross.*

He had some others, Mr. Nicolson, Mr. Van der Bijl—those were the two outstanding men in his group; there were others. Dr. Arnold advocated the use of the vacuum tube as a research tool.

I am a member of the Acoustical Society of America. The Acoustical Society of America, after Dr. Arnold's death, passed a resolution in appreciation of his work on acoustics. Dr.

1781 Dr. Arnold died in August, 1933.

Cross Examination by Mr. Darby:

One of the objects, I believe, of Dr. Arnold's research as to vacuum tubes, was to produce a relay that could be utilized as a relay repeater in connection with transcontinental and trans-oceanic communication. Mr. De Forest brought his audion to us. Up to that time we had not used vacuum tubes, as a relay or repeater in our telephone lines. We used the Shreve repeater.

1782 And the Shreve repeater was a mechanical repeater, and had a little moving part in it. The audion is an inertialess device. Wherever you have a repeater that has a moving part, you are most apt to cause distortion in the currents that are received and relayed. When you say that the audion is an inertialess device, I understand you to mean that it has no moving parts in its operation.

Consequently in using an audion as a relay or repeater, there is no chance for distortion to creep into its operation, due to any movement of any of its parts,—in any of its mechanical parts. It is advisable in telephone practice to

*Paul H. Pierce—For Plaintiffs—Rebuttal—
Cross.*

1783

note accuracy or impedance of every instrumentality that is out any place included in the telephone line. I believe it has been standard practice of the Telephone Company to make a thorough investigation of the impedance in anything that is used in its line. The reasons we made such an exhaustive study of the impedance factors of the vacuum tube, in preparing for its use in telephone lines, was in order to determine the elements of the tube, so that they could be used for this purpose, in telephone practice.

1784

The impedance of any device does not vary in accordance with its geometrical construction. The factors that determine the difference in impedance of the various instrumentalities are wire.

1785

As to whether, with the exception of wire, the impedance of any device varies, in general, with its geometrical construction, well, it seemed to me it only applied to vacuum tubes in particular. It does not to mechanical devices to any great extent. Taking up the particular instance that I gave, of wire, the variation of its impedance in accordance with its diameter is one of the factors. Diameter, I consider one of the geometrical features of the wire. Composition is another, and the impedance will vary in accordance with the composition of the wire.

The ordinary microphone, included in the circuit,—the mouthpiece, to give it a more popular name,—its impedance undoubtedly varies in accordance with the size of the wire that is used in its construction, the strength of the magnet, the size of the magnets.

As to whether the same was generally true

1786 *Paul H. Pierce—For Plaintiffs—Rebuttal—
Cross.*

and whether it is not a fact that I knew it at the time I started my investigation of the audion, that the impedance of practically every instrumentality used in telephone practice differed in accordance with its geometrical construction, well, as I say, the geometry of some resistance elements and inductance elements and capacity elements depended on its geometry.

1787 Mr. Ashton: I offer in evidence Cloud Patent No. 1,907,741 of May 9, 1913.

(Marked Plaintiffs' Exhibit No. 55.)

Mr. Ashton: And I offer in evidence Cloud Patent dated June 28, 1932, No. 1,864,890.

Mr. Darby: I object to these patents as exhibits. They are not relevant or material to any issue in the case.

The Court: I think Mr. Cloud testified concerning this patent.

1788 Mr. Ashton: He testified concerning it, and that is the reason we want it in the record, your Honor. It is the patent, you recall, he said was used to get around the Lowenstein inventions.

The Court: I do not remember his exact words; I do not know that they were just in that form, but I think I know what you are talking about. Objection overruled, and exception.

(Marked Plaintiffs' Exhibit No. 56.)

Mr. Ashton: I offer in evidence the file history of Lowenstein Patent No. 1,231,-764.

(Marked Plaintiffs' Exhibit No. 57.)

Mr. Ashton: File history of Mathes Patent 1,426,754.

(Marked Plaintiffs' Exhibit No. 58.)

Mr. Ashton: File history of Arnold Patent 1,329,283.

(Marked Plaintiffs' Exhibit No. 59.)

Mr. Ashton: File history of Arnold Patent 1,403,475.

(Marked Plaintiffs' Exhibit No. 60.)

Mr. Ashton: File history of Arnold Patent 1,448,550.

(Marked Plaintiffs' Exhibit No. 61.)

Mr. Ashton: File history of Arnold Patent 1,465,332.

(Marked Plaintiffs' Exhibit No. 62.)

Mr. Ashton: File history of Arnold Patent 1,520,994.

(Marked Plaintiffs' Exhibit No. 63.)

Mr. Ashton: The file history of Arnold Patent 1,504,573, for use in connection with Patents 1,403,475; 1,448,550; 1,465,332 and 1,520,994. The reason for that is that this is the original application on which each of those were based.

(Marked Plaintiffs' Exhibit No. 64.)

Mr. Ashton: The Arnold Patent in suit 1,329,283 is based upon the file history of patent or application for patent 1,129,942, so I offer in evidence the file history of that patent 1,129,942 as Plaintiffs' Exhibit 65.

(Marked Plaintiffs' Exhibit No. 65.)

Mr. Ashton: I offer application Serial No. 59,210 filed November 2, 1915, which is an original application upon which Patent 1,448,550 was based.

(Marked Plaintiffs' Exhibit No. 66.)

1792

Case.

Mr. Ashton: I offer in evidence the RCA tubes, cartons and notices for the tubes 201-A, as Plaintiffs' Exhibit 67.

(Marked Plaintiffs' Exhibit No. 67.)

Mr. Ashton: No. 227.

(Marked Plaintiffs' Exhibit No. 68.)

Mr. Ashton: No. 226.

(Marked Plaintiffs' Exhibit No. 69.)

Mr. Ashton: No. 250.

(Marked Plaintiffs' Exhibit No. 70.)

Mr. Ashton: 280.

(Marked Plaintiffs' Exhibit No. 71.)

Mr. Ashton: 281.

(Marked Plaintiffs' Exhibit No. 72.)

Mr. Ashton: I also offer in evidence American Transformer license plate previously marked for identification as Plaintiffs' Exhibit 30.

(Plaintiffs' Exhibit No. 30 for identification received in evidence.)

Mr. Ashton: I offer in evidence photograph of General Talking Pictures "Amer Tran" amplifier previously marked for identification Plaintiffs' Exhibit 31.

(Plaintiffs' Exhibit No. 31 for identification received in evidence.)

Mr. Ashton: I offer in evidence letter of General Talking Pictures Corporation to American Transformer Company, dated November 17, 1928, previously marked for identification as Plaintiffs' Exhibit 32.

Mr. Darby: I have no objection.

(Plaintiffs' Exhibit No. 32 for identification received in evidence.)

Mr. Ashton: I ask that copies be substituted for the originals.

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Mr. Darby: No objection.

Mr. Ashton: I offer in evidence letter of American Transformer Company to the General Talking Pictures Corporation of November 23, 1928, previously marked for identification Plaintiffs' Exhibit 33.

Mr. Darby: I object to this on the ground that it is secondary, in that it is a carbon copy and it is incomplete. The papers referred to therein are not attached. We offered to Mr. Ashton for his use the original, with the papers attached to it.

1796

Mr. Ashton: There is no objection to including in the offer the circular of the American Transformer Company which was attached to the original letter.

The Court: All right, it is understood that the original letter is being offered as Plaintiffs' Exhibit 33, is that it?

Mr. Darby: Yes, your Honor, substituting a photostat copy.

Mr. Ashton: We do the same with the attached circular; we will make a photostatic copy of it.

1797

Mr. Darby: We will furnish the photostats.

(Plaintiffs' Exhibit No. 33 for identification received in evidence.)

Mr. Ashton: I offer in evidence as Plaintiffs' Exhibit 34, photograph of the license notices attached to the defendant's amplifiers previously marked for identification.

Mr. Darby: No objection.

(Plaintiffs' Exhibit No. 34 for identification received in evidence.)

Mr. Ashton: I offer in evidence the General Talking Pictures contract referring to the Strand Theatre, previously marked for identification as Plaintiffs' Exhibit 35.

Mr. Darby: May I ask what its relevancy is?

Mr. Ashton: It is relevant on several grounds. In the first place, it has been testified to by the witnesses and secondly it gives the price of the apparatus, which is an important consideration, your Honor, the price of the defendant's apparatus was \$1,250, and that comes in on the license matter.

The Court: What is the date of that?

Mr. Ashton: The date of it is February 20, 1929.

Mr. Darby: I object to it as irrelevant and immaterial.

The Court: I am afraid I have forgotten it now. I don't think I saw it. Oh, yes, I recall now. This was that Allentown theatre.

1800
Mr. Ashton: The one we discovered in April.

The Court: I think Mr. Schlesinger identified this as being an authentic contract.

Mr. Darby: I do not raise any question about its authenticity, but I do not see how it is relevant or material.

The Court: It may not be, but it won't be alone in that regard.

(Plaintiffs' Exhibit No. 35 for identification received in evidence.)

Mr. Ashton: I offer in evidence as one

exhibit a group of ten photographs of the defendant's amplifiers, which shows the back as well as the front of the amplifiers, and where the notices appear.

(Marked Plaintiffs' Exhibit No. 73.)

Mr. Darby: I may want an opportunity to verify this, your Honor.

The Court: Surely.

Mr. Ashton: I offer in evidence bulletin of the De Forest Radio Telephone and Telegraph Company No. B14 of 1914, which appears at page 130 in the book of plaintiffs' exhibits in the High Vacuum Case, with respect to the license matter. This bulletin shows that the De Forest Company placed upon its amplifiers exactly the same sort of restricted notice that is involved in this case here.

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The Court: And you draw what conclusion from that?

Mr. Ashton: That it has been used by other people.

The Court: Was it not stipulated this morning that that had been common practice?

1803

Mr. Ashton: It was not stipulated that these notices had been used, your Honor, at all. It was stipulated that it was common practice to enter into written license agreements.

The Court: You want to see how that was administered?

Mr. Ashton: Yes, this was an early instance of the De Forest Company putting out these audion amplifiers, right after they began to go into the market, and

1804

Case.

this was admitted that this was put out by the De Forest Company itself; it went into the record, you see, in the High Vacuum Case.

Mr. Darby: On an entirely different basis. I thought I finished that High Vacuum Case once. Your Honor will understand that fundamentally the De Forest Radio Company is not connected in any way with this case.

1805

The Court: I realize that. This company is a sort of predecessor of it though, isn't it?

Mr. Darby: No, it is not connected with it at all. The only link-up with it is that Lee De Forest, the individual, who started the De Forest Radio, is a consulting engineer with this company. Dr. De Forest for a great many years devoted his time exclusively to radio.

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The Court: Can't you accomplish your purpose by reading into the record what this notice is?

Mr. Ashton: The bulletin referred to contains the following license notice:

"De Forest Audion License for private, amateur or experimental use only. The only audion detector manufactured for the use of amateurs under the protection of the patents of Dr. Lee De Forest."

Mr. Darby: I object to its use, for the sake of the record, your Honor.

The Court: All right, I overrule the objection and exception.

Mr. Ashton: I offer in evidence the letter of Walter S. Gifford, President of the American Telephone and Telegraph Company to Mr. Edgar S. Bloom, president of the Western Electric Company, dated November 6, 1926, which is a letter granting certain rights of the Telephone Company to the Western Electric Company, and that has to do with the subject matter which the witness has testified to as to their right and authority.

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Mr. Darby: May I read that letter?

Mr. Ashton: Yes. It is in the chain of title alleged in the bill.

Mr. Darby: We do not question the chain of title. We do object to it as immaterial. Is there any issue on title?

Mr. Ashton: No, there is no issue on the chain of title, but there is a question of right between the Western Electric and Electrical Research Products,—

The Court: Does this add to or detract from their contracts?

1809

Mr. Ashton: We show what the rights were. We show that the Western Electric and Electrical Research Products could not have furnished rights to the defendant.

The Court: And therefore?

Mr. Ashton: Therefore it has a direct bearing on the testimony of the witnesses, that they made no statements to Mr. Schlesinger.

The Court: All right.

1810

Case.

Mr. Darby: I object to it as irrelevant and immaterial.

The Court: Overruled and exception.

(Marked Plaintiffs' Exhibit No. 74.)

The Court: That is a letter written November 6, 1926, is it?

Mr. Darby: Yes, your Honor.

Mr. Ashton: And I offer in evidence the other agreement granting licenses to Western Electric and Electrical Research Products, dated May 7, 1929, for the same purpose.

Mr. Darby: The same objection.

The Court: Same ruling and exception.

(Marked Plaintiffs' Exhibit No. 75.)

Mr. Ashton: I offer in evidence the contract license agreement between Radio Corporation of America and Raytheon Manufacturing Company, dated March 19, 1929, which is the company defendant testified from which it purchased vacuum tubes.

Mr. Darby: I object to the receipt of the license. I read into the record the license notice that was in the agreement and I submit that serves this purpose.

The Court: Is there any question that Raytheon tubes were sold under restricted licenses, and they could be sold under the terms of the notices?

Mr. Ashton: The notice does appear in the record, but the entire contract does not. I offer the contract simply for the sake of the completeness of the record. I do not press it if there is any serious objection.

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The Court: All right.

Mr. Ashton: I offer in evidence the draft letter of American Transformer Company to General Talking Pictures Corporation of July 3, 1929, previously marked for identification as Plaintiffs' Exhibit 29.

Mr. Darby: I object to that. I don't know what its purpose is. Certainly its origin has not been established.

Mr. Ashton: Your Honor will recall the discussion and the arrangement that was made at the time that the offer would be withdrawn at that time and I stated that the letter would be re-offered at a later stage in the case. I think the basis for the receipt of the letter has been established.

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The Court: You think the authenticity of the letter has been established?

Mr. Ashton: It has been established definitely that the letter did not originate with the American Transformer Company.

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The Court: Assume that that is so: That leaves about 90 degrees on the horizon uncovered, doesn't it?

Mr. Ashton: It shows it was something submitted from the outside; it originated from the outside.

The Court: And therefore?

Mr. Ashton: And therefore it should be received. If there is any objection to it on the ground that it came from the files of the American Transformer Company and was not prepared by them,—I think that has already been established that it

1816.

Case.

was not prepared by them,—we can prove it came from the files of that company. I don't think there is any question though that it did.

The Court: Mr. Ashton, is it not pretty well conceded by everybody connected with the transaction that those two letters Exhibits J and K, I think, had their origin in conversations that perhaps were carried on as many as three times, and that it was the desire of both parties to be precise in stating the exact representation. That much is clear, isn't it?

Mr. Ashton: I think it is, your Honor.

The Court: Now, does it greatly matter whether there was another unattached literary production?

Mr. Ashton: I think this shows the origin of the whole transaction.

The Court: If there was anyone who could identify the pencil notations, I would agree with you, but no one can.

Mr. Ashton: There is a witness right here who can say that he wrote this.

The Court: But he has not testified.

Mr. Ashton: I propose to call him if your Honor does not exclude it on broad grounds.

The Court: I don't think it is connected yet.

Mr. Ashton: Mr. Neave reminds me that possibly your Honor does not recall that the reason we want it particularly is that it shows the differences between the original and the one that was actually sent. You recall that matter?

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*John L. Schermerhorn—For Plaintiffs—
Rebuttal—Direct.*

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The Court: There is a difference between J and K.

Mr. Ashton: Yes, a difference and between this 29 and the other two also.

The Court: I realize that. I looked at 29 although it is not in evidence and I do not think I would be justified in basing any finding on it.

Mr. Ashton: Yes, your Honor.

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JOHN L. SCHERMERHORN, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is John L. Schermerhorn, I reside 41 South Munn Avenue, East Orange, N. J. I am vice-president of the American Transformer Company. I have been connected with the company since July, 1929.

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By the Court:

I was vice-president in July of 1929.

By Mr. Ashton:

The handwriting in the upper left-hand corner of this letter, Plaintiffs' Exhibit 29 for identification, is mine. I placed it there possibly a year and a half ago, I don't know definitely.. I

1822

*John L. Schermerhorn—For Plaintiffs—
Rebuttal—Direct.*

removed the letter from the files of the American Transformer Company.

By the Court:

I do not know who put it in the files. I did see it before a year and a half ago. I saw it in July, 1929. It was shown to me by Mr. Loughead. I believe so. Mr. Hunter of our company was also present.

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By Mr. Ashton:

I do not know where the letter originated. I believe it was not prepared by my company because our company never used letter paper like that.

Mr. Ashton: I now offer the letter of July 3, 1929, in evidence.

Mr. Darby: I object to its receipt in evidence.

The Court: Sustained.

Mr. Ashton: Exception.

Mr. Darby: No cross examination.

Mr. Ashton: I understand that there is no objection to the letters, as far as the proof is concerned, on these matters of correspondence between Radio Corporation and American Transformer Company, is that correct, Mr. Darby?

Mr. Darby: That is correct, providing they are the letters that we have discussed and examined prior to the trial.

Mr. Ashton: Here are two letters that you have not examined and there are two more here.

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Mr. Darby: I do not put you to the proof as to these letters, but I object to them as irrelevant and immaterial.

Mr. Ashton: They show that the American Transformer Company was fully notified as early as September 13th.

Mr. Darby: Will you let the Court read them to see what they show?

Mr. Ashton: I am just telling you because I thought it could shorten it.

(Document handed to the Court.)

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The Court: I will allow it.

Mr. Berliner: May I add an objection based on this ground: What the Radio Corporation of America in an exchange of correspondence with the American Transformer Company in September of 1927 did, does not bind this defendant, and certainly it does not bind the respective transactions that these parties had between themselves.

The Court: I agree with you entirely.

Mr. Berliner: Exception.

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Mr. Ashton: I would like to suggest that all these letters relating to the refund of royalties, and so forth, be marked as one exhibit.

I will ask that the letter of September 13, 1927, from American Transformer Company to the Radio Corporation of America; and the letter of September 16, 1927, from Radio Corporation to American Transformer Company be marked as one exhibit, Plaintiffs' Exhibit 76.

(Marked Plaintiffs' Exhibit No. 76.)

Mr. Ashton: As to this correspondence

1828 Ewen C. Anderson—For Plaintiffs—Rebuttal—
Direct.

between Radio Corporation and American Transformer Company, Mr. Anderson will testify that he communicated with these people before the letter was sent. I will put him on for that purpose.

1829 Ewen C. Anderson, called as a witness on behalf of the plaintiffs, in rebuttal, having been duly sworn, testified as follows:

Direct Examination by Mr. Ashton:

My name is Ewen C. Anderson. I am license administrator of the Radio Corporation of America. I communicated with the American Transformer Company in November, 1929, with respect to its license.

1830 The Court: That is two months after
this suit was brought.

Mr. Ashton: That is true.

By Mr. Ashton:

I communicated with American Transformer Company prior to November, 1929; in the late summer of 1929. I called Mr. Schermerhorn, vice-president of the company on the telephone and told him that I had some matters that I wanted to discuss with him regarding his operations. Mr. Schermerhorn then called on me at my office and I advised him he was selling apparatus to which he was not licensed, and I

*Ewen C. Anderson—For Plaintiffs—Rebuttal—
Direct.*

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pointed out also to him several advertisements that his company had used in advertising apparatus outside the scope of his license. I notified the other licensees who had similar licenses.

Q. Did you do it by letter such as the letter of November, 1929?

Mr. Darby: I object to what he did with others as incompetent, irrelevant and immaterial.

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The Court: I will sustain the objection.

Mr. Darby: No cross examination.

Mr. Ashton: I offer the letter of November 14, 1929, with Mr. Anderson's memorandum to Mr. Schairer, his superior of that date, stating that he had communicated with the American Transformer people.

The Court: I don't think this letter adds anything to his testimony.

Mr. Ashton: I now offer in evidence as one exhibit the following letters. Mr. Darby, can we agree that we can read these letters into the record without holding the Court here?

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Mr. Darby: Are those the letters that we have gone over and agreed on?

Mr. Ashton: You have seen them all. They are exactly the ones you have seen.

I offer in evidence as one exhibit the following papers:

1. Letter from Radio Corporation to American Transformer Company of December 18th, 1930, and attached schedules A and B;

1834

Case.

2. Letter of American Transformer Company to Radio Corporation, dated January 5, 1931;

3. Letter of Radio Corporation to American Transformer Company of April 17, 1931;

4. Letter of Arthur Young & Company to Radio Corporation of America of May 15, 1931;

5. Letter of Radio Corporation of America to American Transformer Company of June 10th, 1931, and attached schedule;

6. Letter of Radio Corporation to American Transformer Company of June 22, 1931;

7. Letter of Radio Corporation to American Transformer Company of December 30, 1931, and attached schedules A, B, C and D;

8. Letter of Radio Corporation to American Transformer Company of January 7, 1932;

9. Check of Radio Corporation of America to American Transformer Company, dated December 9, 1930, both face and back, the check showing endorsements;

10. Check of Radio Corporation of America to American Transformer Company of June 4, 1931, both face and back, showing endorsements.

Mr. Berliner: We object to the admission of this evidence, on the ground it is incompetent, irrelevant and immaterial, not binding upon the defendant, being transactions with respect to alleged refunds of royalties between the American

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*John L. Schermerhorn—For Defendant—Sur-
Rebuttal—Direct.*

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Transformer Company and the R. C. A.

The Court: Objection overruled.

Mr. Berliner: Exception.

(Marked Plaintiffs' Exhibit No. 77.)

Mr. Ashton: I offer in evidence the file history of Arnold application Serial Number 841,567, filed May 28, 1914.

(Marked Plaintiffs' Exhibit No. 78.)

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SUB-REBUTTAL PROOFS.

EMANUEL M. ZELONY, recalled as a witness on behalf of the defendant, in sur-rebuttal, having been previously sworn, testified further as follows:

Direct Examination by Mr. Darby:

I was in the courtroom when Mr. Otterson testified. He is the gentleman I saw when I had the conversation that I previously testified about.

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JOHN L. SCHERMERHORN, called as a witness on behalf of the defendant, in sur-rebuttal, having been previously sworn, testified as follows:

Direct Examination by Mr. Darby:

I heard the testimony of Mr. Anderson. I had a conversation with Mr. Anderson of the substance that he testified about. That occurred in October or November, 1929.

1840 *Stipulation and Order Approving Narrative Statement of the Evidence.*

Mr. Darby: Upon the strength of Mr. Schermerhorn's testimony I move to strike out the testimony of Mr. Anderson.

The Court: They may both stand.

Mr. Darby: Exception.

(Defendant rests. Case closed.)

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Stipulation and Order Approving Narrative Statement of the Evidence.

The foregoing narrative statement of the testimony, taken at the trial, having been presented to me, the same is hereby approved and allowed, and is ordered filed as a statement of the evidence to be included in the record on appeal, as provided by Equity Rule 75.

Dated, March , 1937.

1842

MORTIMER W. BYERS,
U. S. District Judge.

Consented to.

HENRY R. ASHTON,
Solicitor for Plaintiffs.

SAMUEL E. DARBY, JR.,
Solicitor for Defendant.

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